SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, FEBRUARY 7, 1902.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CARNEGIE INSTITUTION.

THE first meeting of the trustees of the Carnegie Institution was held in Washington on the 29th and 30th of January. Nearly all the members of the board were present and two sessions were devoted to a consideration of the important business entrusted to them by Mr. Carnegie. The Hon. John Hay, Secretary of State, presided on the first day and, at the second session, the Hon. Abram S. Hewitt, who had in the meantime been made permanent chairman of the board. The most interesting incident of the meeting was the appearance of the founder who in a very clear and modest way read the deed of trust by which he conveyed to the Carnegie Institution ten millions of dollars in five per cent. bonds of the United States Steel Corporation. After reading this deed, he proceeded to unfold in more familiar language the purposes that he had in view, which are not different from those already indicated, although he amplified certain points which had only been briefly mentioned before. Among other things he said in substance that he had been tempted to associate the name of George Washington with this gift

of his, but on reflection he had reached the conclusion that it would be unwise to do so. He also stated that the Carnegie Institution would not be such a national university as Washington thought possible in his day. Mr. Carnegie also gave emphasis to his repeated desire that the income of the fund should be largely devoted to extending human knowledge by original investigation and research. This would involve the selection of individual co-workers of exceptional powers. It would also lead to the publication of important memoirs. Beyond these fundamental restrictions the trustees are left free to proceed as they may think best from time to time. Accordingly, an executive committee of seven persons was authorized to formulate plans and to take such preliminary steps as might be important before the annual meeting of the trustees in November next. This committee consists of the president of the Carnegie Institution, Daniel C. Gilman, the four gentlemen with whom Mr. Carnegie has been advising during the last few weeks, namely: Hon. Abram S. Hewitt, Dr. John S. Billings, Hon. Carroll D. Wright and Hon. Charles D. Wolcott, and, in addition, Hon. Elihu Root and Dr. S. Weir Mitchell. The executive committee immediately after their appointment proceeded to discuss the next step to be taken and determined to begin by opening, temporarily, rooms in Washington at No. 1439 K Street, where conferences may be held. Next they propose to correspond with men in all parts of the country who are acknowledged leaders in science (using the word science in a very broad sense), and after their answers are received to consider the suggestions they may make, preliminary to future action. They also propose to make a diligent inquiry respecting all the kindred agencies that are now promoting research under the auspices of the government or under the direction of universities and technical schools. The experience of foreign countries will also be carefully studied.

From this statement it will be obvious that the further development of this new institution will be slow and gradual. It is not expected that scholarships will be established at present, and all requests for assistance will be laid before the executive committee.

These points should be borne in mind. The great object of the foundation is the advancement of knowledge. The methods are left to the free action of the trustees, who will await the carefully matured suggestions of the executive committee. Nothing has been done in founding the new institution to further or to hinder the establishment of a national university which has been so many times proposed to Congress. Nothing is projected which will in any way interfere with the purpose of the George Washington Memorial Association to secure the funds requisite for the erection of a memorial building. Nor has there been any step taken which will prevent the Washington Memorial Institution, initiated early in the last summer, from developing plans for the introduction of students to the various scientific bureaus of Washington.

The Carnegie Institution is simply a new

force for the promotion of science, ready to cooperate with other institutions which are now or may be established in Washington or elsewhere. By its very foundation it is precluded from any thought of rivalry. If the founder's hopes are realized his wise and munificent bounty will benefit not only our own country but the interests of mankind.

D. C. G.

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*THE WRECK OF MT. MAZAMA.**

INTRODUCTION.

THE geological record of this country from the earliest epochs to the present time is replete in volcanic phenomena, but the climax in such matters appears to have been reached in the earlier portion of the Neocene, when one of the largest known volcanic fields of the world was vigorously active in our Northwestern States. It stretches from the Rocky Mountains to the Pacific, embracing a large part of Wyoming, Montana, Idaho, Washington, Oregon and California, and presents a great variety of volcanic phenomena concerning which, notwithstanding a copious literature, there has been as yet but a small amount of detailed investigation. The work of the Geological Survey has taken me across this field in various directions and afforded an extended opportunity at intervals during nearly a score of summers upon the Pacific coast to study the western portion of the field. Instead of attempting a summary of what has been done in this large field, as perhaps might be expected upon this occasion, I beg to call your attention more particularly to a special feature in the volcanology of the Cascade Range, which, so far as I am aware, is not well represented in any other portion of the field nor in fact anywhere else within the United States. To set forth more clearly the wreck of Mt. Mazama, which is the central theme, it is necessary to consider briefly the general relations of the whole range.

* Abstract of Presidential address delivered before the Geological Society of Washington, Dec. 18, 1901. The full address with geological map and illustrations will probably appear as a bulletin of the U. S. Geological Survey.

LIMITS OF THE CASCADE RANGE.

The western limit of the great volcanic field is marked by the corresponding border of the Cascade Range, which is made up at least largely, if not wholly, of volcanic material erupted from a belt of vents extending from northern California to central Washington. Lassen Peak marks the southern end of the Cascade Range and Rainier is near the northern end. Beyond these peaks the older rocks rise from beneath the Cascade Range and form prominent mountains, the range itself occupying a depression in these older terranes.

FOUNDATION OF CASCADE RANGE.

A clearer conception of the development of the Cascade Range may be gained by considering the geography of the region during the later portion of the Cretaceous. At that time the coast of northern California, Oregon and Washington subsided, causing the sea to advance upon the land. In California it reached the western base of the Sierra Nevada and covered a large part, if not the whole, of the Klamath Mountains. In Washington it beat upon the western base of the range near the coast north of Mt. Rainier, but in Oregon it extended far into the interior. Marine deposits of this period occur along the base of the Blue Mountains in eastern Oregon. The Cascade Range of Oregon did not then exist to shut out the open sea from that region. East of the Klamath Mountains, as shown by the position and distribution of the Cretaceous strata and their fossils of marine origin, the open sea connected directly with that of the Sacramento Val-

ley. The Cascade Range throughout a large part of its extent rests upon Cretaceous rocks and is associated in Oregon and California with a depression in the older rocks between the Klamath Mountains on the one hand and the Blue Mountains and Sierra Nevada upon the other. This depressed area beneath the lavas of the Cascade Range must not be regarded primarily as a region of subsidence. Its chief movement since the Cretaceous has been upward. It has been raised above the sea. The Klamath and Blue Mountains, as well as the Sierra Nevada, however, have been elevated so much more that the region in question would appear on the surface as a depression were it not filled with lava. The depression is so deep where the Cascade Range is cut across by the Klamath and Columbia rivers that the bottom of the lavas forming the bulk of the range is not reached. However, at the ends of the range the older rocks rise to form a more or less elevated base for those parts of the range, and at Mt. Shasta as well as on the divide between the Rogue and Umpqua rivers, where an arch of the older rocks extends northeasterly from the Klamath Mountains towards the Blue Mountains of eastern Oregon, the Cascade Range gets so close to the western side of the depression that the lavas lap up over the arch of older rocks rising to the westward. At various points of the range granolitic rocks, such as gabbro and diorite, occur, but the deep erosion at these points may have reached the granolites corresponding to the lavas of the upper portion of the range.

CASCADE RANGE DURING THE EOCENE.

There can be no reasonable doubt that fossiliferous Cretaceous rocks of marine origin are widely distributed beneath the Cascade Range from Lassen Peak to the Columbia, and that during the Chico epoch the whole area was beneath the sea. At the close of the Chico important changes occurred in the distribution of land and sea. Northern California, as well as southern Oregon, was raised above the sea and subjected to extensive erosion before the subsidence which admitted the sea during the early part of the Tertiary as far southeast as Roseburg, Oregon. The marine deposits of the Eocene epoch in the vicinity of Roseburg run under the Cascade Range, but have not yet been found upon the eastern side. The conglomerates of the Eocene, like those of the Cretaceous, contain many pebbles of igneous rocks, but they are of types common to the Klamath Mountains and rare or unknown among the lavas exposed in the Cascade Range. During the Eocene in the Coast Range of Oregon there was vigorous volcanic activity,* but the record of such activity, if such existed, has not yet been found in the Cascade Range. That volcanoes were active along the range during the Eocene is rendered more probable although not yet conclusive by Dr. J. C. Merriam's discovery of Eocene volcanic deposits in the John Day region.†

CASCADE RANGE DURING THE MIOCENE.

There can be no doubt, however, that during the Miocene‡ the volcanoes of the Cascade Range were most active and the greater portion of the range built up, although it is equally certain that volcanic activity continued in the same region at a number of points almost to the present time. While it may be presumed that the volcanoes of the Cascade Range are extinct, there are many solfataras, hot springs and fumeroles, showing that the volcanic energy of the range is not yet wholly dissipated.

* U. S. Geol. Survey, Seventeenth Annual Report, Part I., p. 456.

† *Bulletin Geol. Dept. of Univ. of Cal.*, Vol. 2, No. 9, p. 285.

‡ U. S. Geol. Survey, 20th Annual Report, 1898–9, Part III., p. 32.

All the peaks of the Cascade Range were once active volcanoes, and from them came most of the lava of the range. Each great volcano was surrounded within its province, at least during the later stages, by numerous smaller vents from which issued the lava that filled up the intervening spaces and built up the platform of the range.

All of the great volcanoes of the range probably had their beginning in the Miocene. Many of them, like Lassen Peak and Mount Shasta, continued their activity into the Glacial Period and have suffered much erosion since they became extinct. In this manner important structural differences have been brought to light among the peaks about the headwaters of the Umpqua, Rogue river and the Klamath, and these may be noted as throwing some light upon the history of Mt. Mazama, whose wreck we are to consider.

UNION PEAK.

Union Peak (7,881 feet) is on the summit of the Cascade Range in Oregon about 50 miles north of the California line, and 8 miles southwest of Mt. Mazama. It is a sharp conical peak rising about 1,400 feet above the general summit of the range. About the base upon the east and west sides, as well as upon its very summit, are remnants of the original tuff cone, but the mass of the peak exposed upon all sides is solid lava. The molten material did not sink away after the final eruption. The volcanic neck resulted from the cooling of lava within the cinder cone in the very top of the volcanic chimney, and Union Peak to-day shows us the neck stripped of its cinder cone.

MT. THIELSEN.

Mt. Thielsen (9,250 feet), the Matterhorn of the Cascade Range, is 12 miles north of Mt. Mazama and rises about 2,000 feet above the general summit of the range. It is built up of brightly colored red, yellow and brown layers of tuff interbedded with thin sheets of lava, and the whole is cut by a most interesting network of dikes radiating from the center of the old volcano. No trace of a volcanic neck is present; the peak is but a remnant carved out of the lava and tuff cone surrounding the vent. After the final eruption the molten material withdrew from the cone before consolidation so as to leave no volcanic neck corresponding to that of Union Peak. The subsidence after eruption within the chimney of Mt. Thielsen must have been over 1,000 feet, for the sheets of lava effused from that vent reach more than 1,000 feet above the central portion of the peak.

MOVEMENT IN MT. MAZAMA.

To simplify matters it seems best at this point to anticipate some of the conclusions to be reached and state that upon what is known as the rim of Crater Lake there once stood a prominent peak to which the name Mt. Mazama has been given. The crowning event in the volcanic history of the Cascade Range was the wrecking of Mt. Mazama, which resulted from a movement similar to that just noted in Mt. Thielsen but vastly greater in its size and consequences. It culminated in the development of a great pit or caldera, which for grandeur and beauty rivals anything of its kind in the world.

Mt. Mazama is practically unknown to the people of Oregon, but they are familiar with Crater Lake, which occupies the depression within the wreck of the great peak. The destruction of the mountain resulted in the formation of the lake, and the remnant of Mt. Mazama is most readily identified when referred to as the 'rim of Crater Lake.'

CASCADE RANGE SUMMIT.

The Cascade Range in southern Oregon is a broad irregular platform, terminating

rather abruptly in places upon its borders, especially to the westward, where the underlying Cretaceous and Tertiary sediments come to the surface. It is surmounted by volcanic cones and coulees, which are generally smooth but sometimes rough and rugged. The cones vary greatly in size and are distributed without regularity. Each has been an active volcano. The fragments blown out by violent eruption have fallen about the volcanic orifice from which they issued, and built up cinder cones. From their bases have spread streams of lava, raising the general level of the country between the cones. From some vents by many eruptions, both explosive and effusive, large cones, like Pitt, Shasta and Hood, have been built up. Were we to examine their internal structure, exposed in the walls of the canyons carved in their slopes, we should find them composed of overlapping layers of lava and volcanic conglomerate, a structure which is well illustrated in the base of Mt. Mazama.

VIEW OF MT. MAZAMA FROM A DISTANCE.

Approaching Crater Lake from any side the rim by which it is encircled, Mt. Mazama, when seen at a distance, appears as a broad cluster of gentle peaks rising about a thousand feet above the general crest of the range on which it stands. The topographic prominence of Mt. Mazama can be more fully realized when it is considered as the head of Rogue River and sends large contributions to the Klamath River, besides being close to the head of the Umpqua. These are the only large streams breaking through the mountains to the sea between the Columbia and the Sacramento, and their watershed might be expected to be the principal peak of the Cascade Range.

GENERAL VIEW OF MT. MAZAMA AND ITS LAVAS.

Arriving by the road at the crest of Mt. Mazama, the lake in all its majestic beauty appears suddenly in view and is profoundly impressive. The long gentle slope upon the outside at the crest is changed to a precipice. Nearly 20 miles of irregular cliffs ranging from 500 to nearly 2,000 feet in height encircle the deep blue lake and expose in sections many streams and sheets of lava and volcanic conglomerate which radiate from the lake as a center. Along the southern border the rim above the lake level has many superimposed flows, but upon the northeast where it is not so high it is composed largely of one great flow which coursed down a ravine of the ancient Mt. Mazama.

The rim is cut by a series of eleven dikes, one of which is prominent and reaches from below the lake level to the rim crest. Others rise only part way and spread into flows for which they afforded an outlet. Near the west border of the lake is Wizard Island with its lava field and cinder cone surmounted by a perfect crater.

Three kinds of lava occur in Mt. Mazama, andesite, dacite* and basalt. The andesites form nearly nine-tenths of the mass of the rim. Dacites, generally accompanied by pumice, form the surface flows upon the north and east crest of the rim and are everywhere underlain by andesites. Both came from the central vent of Mt. Mazama, which, however, furnished no basalt. It all came from a number of small volcanic cones upon the outer base of the mountain. The dacites are younger than the basalts, for showers of dacite pumice fell in the extinct craters of the basalt cones. As the oldest lavas of Mt. Mazama are andesites, so are the latest, for the lava of Wizard Island is andesite which was poured out upon the floor of the caldera after the destruction of Mt. Mazama. It marks the beginning of a second petrographic cycle from the same vent.

* My collections were studied by Dr. H. B. Patton, who now regards as dacites what I have heretofore called rhyolites.

ORIGINAL CONDITION OF MT. MAZAMA.

Thus far the existence of an original Mt. Mazama has been assumed. The evidence on which this assumption is based may be briefly stated as follows: The inner slope of the rim presents sections of the broken lava flows which radiate from the lake and were evidently effused from a source higher in each case than the respective flow in the rim. If the flows of the rim were to be restored to their original size by extending them inwards from the rim, as they once certainly did, they would converge to a common source and make a volcano which would occupy the place of the caldera and make a prominent peak, Mt. Mazama.

The peak must have had a crater similar in character to that of Wizard Island, for it was the source of much fragmental material spread in all directions upon the mountain slope.

The former existence of Mazama Peak is indicated also by the radial series of dikes which cut the rim. They evidently originated in the pressure of the column of molten material in the chimney of a volcanic peak rising some distance at least above the rim.

The most convincing evidence of the existence of Mt. Mazama on the site of Crater Lake is to be found in the glaciation and drainage of the rim. The radiating glaciers, which in their descent scored the crest of the rim, could have come only from a central peak. The records of the ice and water drainage from the peak in the topography of the rim are unmistakable.

There can be no reasonable doubt as to the former existence of Mt. Mazama, but its shape and size are more difficult to determine. Mt. Mazama is composed largely of lavas similar to those of Mt. Shasta, and from the slopes of that famous peak we may draw an inference as to those of Mt. Mazama. Mt. Shasta, unlike Mt. Mazama, does not stand on an elevated platform. It rises with a majestic sweep of 11,000 feet from gentle slopes about its base, gradually growing steeper upwards to the bold peak. At the height of 8,000 feet it has about the same diameter as Mt. Mazama at an equal elevation in the rim of Crater Lake. Above this Mt. Shasta rises over 6,300 feet. The prominence of Mt. Mazama as a drainage center is quite equal to that of Mt. Shasta, but its slopes on the rim of Crater Lake, ranging from 10 to 15 degrees, are scarcely as great as those of Mt. Shasta at a corresponding elevation. On the other hand, the canyons of Sun and Sand creeks on Mt. Mazama are more profound and have been much more deeply glaciated than any of those on Mt. Shasta. It therefore appears reasonable to suppose that Mt. Mazama had an altitude at least as great and possibly greater than that of Mt. Shasta (14,380).

DEVELOPMENT OF MT. MAZAMA.

Mt. Scott is only a large adnate cone to Mt. Mazama. It belongs to the same center and holds essentially the same relation to it as Shastina does to Shasta. The slopes of Mt. Mazama reach to the plains at its eastern base, and it is one of the largest members in the composition of that range.

The beginnings of Mt. Mazama are now deeply buried beneath the lavas of the range, including those displayed on the lower slopes of the great caldera beneath the water of Crater Lake. The earliest lavas now visible are those of the southern and western lake border, and when they were erupted the volcano was normally active, sending out with its streams of lava large contributions of fragmental material to make the heavy conglomerates of the older portion of the rim. The many succeeding flows of andesite and layers of conglomerate built up the mountain slope to the crest of the rim upon the southern

and western side, and Mt. Scott, too, had attained its full development when the principal vents of basalt opened and by a series of eruptions built up the surrounding country with adnate cones upon the outer slope of the rim of the lake. Then followed the large eruptions of dacite forming Llao Rock and the northern crest of the rim to Cloud Cap. These flows occurred during the period of glaciation of Mt. Mazama, and streams of lava alternated with streams of ice, a combination which doubtless gave rise to extensive floods upon the slopes filling the valleys below with volcanic débris from the mountain. In connection with the eruption of these viscous lavas (dacites) there were great explosive eruptions of pumice, spreading it for 20 miles or more across the adjacent country. The explosive activity of Mt. Mazama culminated in the eruption of the peculiar dark pumice rich in hornblende which followed the outflow of the tuffaceous dacite.

DESTRUCTION OF MT. MAZAMA—ORIGIN OF THE CALDERA.

Then came the revolution which removed the upper 6,000 feet of Mt. Mazama, as well as a large core from its base, and gave rise to the caldera. How was this change produced?

There are only two ways in which it could have been effected: either by an explosion which blew it away, or a subsidence which engulfed it.

The occurrence of vast quantities of pumice spread for a distance of 20 miles in all directions about the base of Mt. Mazama is evidence of a most tremendous explosive eruption at that point, an eruption the equal of which, so far as known, has not yet been found anywhere else in the Cascade Range. Vast quantities of fine material were blown out at the same time and by drainage gathered into the surrounding valleys, which it fills to an extent unknown, as far as I have observed, upon the slopes of any of the other great volcanoes of the range.* This impressive evidence shows conclusively that a late, if not the final, eruption of Mt. Mazama was explosive, and of such magnitude as to suggest that the removal of the mountain and the origin of the caldera may be counted among its effects. This suggestion, however, is not supported by the evidence resulting from a study of the ejected material and its relation to the lava flows of the rim. The fine material filling the valleys and the pumice throughout its great area is hornblendic in character and belongs to the dacites of the rim. Andesitic material may be present locally, but its occurrence is exceptional. Practically the whole of the material ejected by the final explosion is dacite. The eruption therefore was of the usual type and not of the kind which removes mountains. As far as may be judged from the pumice deposits in the rim, the greatest eruption of that sort of material from Mt. Mazama occurred before the extrusion of the dacite of Llao Rock, and furnishes evidence that the greatest explosion occurred long before the destruction of Mt. Mazama.

There is another matter of importance bearing directly upon the explosive theory of the caldera which renders that theory wholly untenable and fully corroborates the conclusion derived from a study of the character and distribution of the pumice. The lava exposed upon the inner slope of the rim is chiefly andesite, and its relation is such as to indicate that solid sheets of andesitic lava formed by far the larger part of Mt. Mazama. If the caldera resulted from an explosion this mass of andesitic flows would be broken to frag-

* As far as my own observation goes, the above remarks apply to Lassen Peak, Mt. Shasta, Mt. Pit, Mt. Thielsen, Diamond Peak and Mt. Hood.

ments and blown out to fall around the caldera and form a rim of fragmental material. From the size of the lake and the remaining portion of Mt. Mazama it is possible to compute approximately what the size of the rim formed in this way would be. But before we can do this it is necessary to consider the size and shape of the caldera, especially that part which lies beneath the lake.

THE BOTTOM OF CRATER LAKE.

To determine the configuration of the bottom of Crater Lake a large number (168) of soundings were made under the direction of Major Dutton. His results were published by the U. S. Geological Survey upon a special map of the lake, scale 1: 62,500 with a contour interval of 100 feet. The principal lines of soundings are noted, including 96 of the 168 measured depths. From these data, together with information from Mr. W. G. Steel, who was present when the soundings were made, the bottom has been roughly contoured upon the large scale map with a vertical interval of 500 feet. The positions of the two sublacustrine cones were indicated, and it is clear from the soundings that a large mass of lava spread from the Wizard Island vent over the lake floor. The great deep toward the eastern margin of the lake may not have been filled up any after the caldera was formed, but it is evident that the depth of the western portion has been greatly reduced by the material erupted from the three small vents upon its floor. It appears well within the bound of reason to assume that 1,500 feet is not greater than the average depth of the original caldera below the present level of the lake.

ESTIMATED SIZE OF FRAGMENTAL RIM.

The area of the caldera, as marked out by the crest of the rim, is over 27 square miles, and its original volume, making some allowance for the subsequent refilling from the craters on its floor, is about 12 cubic miles. If to this we add 5 cubic miles for the part of the mountain above the caldera, and this is a conservative estimate, we get 17 cubic miles of material for whose disappearance we have to account. If this material were blown out by a great explosion and fell equally distributed upon the outer slope of the rim, within three miles of the crest it would make a layer over 1,000 feet in thickness. This mass would be so conspicuous and composed of such fragmental material that its presence could not be a matter of doubt. There can be no question concerning its complete absence, for the surface of the outer slope of the rim exposes everywhere either glaciated rock, glacial moraine or pumice, all of which are features which belonged to Mt. Mazama before its destruction, and no trace of a fragmental rim, such as is referred to above, was found anywhere.

The evidence of the outer slope of the rim lends no support to the view that Mt. Mazama was blown away and the caldera produced by a great volcanic explosion. In fact, it completely negatives such a view, and we are practically driven to the opinion that Mt. Mazama has been engulfed. Major Dutton, who studied the rim of Crater Lake with a training gained from among the active volcanoes of the Hawaiian Islands, recognized the wide distribution of the pumice, but the absence of a well-defined fragmental rim kept him from attributing the origin of the caldera to an explosion. On the other hand, he fully appreciated the difficulty of proving that it originated in a subsidence.*

The present inner slope of the rim may not in all cases, or even generally, be the one formed at the time of the collapse. In some cases, however, the inner slope was

* U. S. Geological Survey, 8th Ann. Rept., Part I., p. 157.

formed at that time. Of this we have evidence in the behavior of the flow at Rugged Crest. It was one of the final flows from the slope of Mt. Mazama. Before the central portion of the flow where thickest had congealed within the solid crust, Mt. Mazama sank away and the yet viscous lava of the middle portion of the stream flowed down over the inner slope of the andesitic rim into the caldera. The liquid interior of the flow having withdrawn, the crust caved in and formed Rugged Crest with its peculiar chaotic valley of tumbled fragments, columns and bluffs. Other explanations of the peculiar reversed flow of Rugged Crest have been sought, but without avail. The facts are so simple and so direct that they appear to preclude any other hypothesis.

It would be apparent from the facts also that the collapse of the mountain was at least moderately sudden, for it is not at all probable that the Rugged Crest flow was long exposed before reaching the present level of the lake and beyond into the caldera.

We may be aided in understanding the origin of the caldera by picturing the condition that must have obtained during the eruption of the Rugged Crest dacite from the upper slope of Mt. Mazama. At that time a column of molten material rose in the interior of the mountain until it overflowed at the summit or burst open the sides of the mountain and escaped through the fissure. The rent of the mountain side is formed in such cases by the pressure of the column of molten material it encloses. The molten lavas being heavy, the pressure of the column within the mountain is very great, and increases rapidly with the height of the volcano. During the final activity of Mt. Mazama there must have been within it a column of lava over 8,000 feet in height above the base of the Cascade Range. It is possible that on account of this great pressure, aided possibly by some other forces, an opening was formed low down upon the mountain slope, allowing the lava to escape. The subsidence of the lava within the mountain left it unsupported and caused its collapse. Phenomena of this sort are well known in connection with the Hawaiian volcanoes. In 1840, according to Professor J. D. Dana, there was an eruption from the slopes of Kilauea, 27 miles distant and over 3,000 feet below the level of its summit. At Kilauea the summit of the lava column is well exposed in a lava lake. In connection with the eruption of 1840 the lava of the lake subsided to a depth of 385 feet, and the irregular walls surrounding it left without support broke off and fell into the molten material below. During the intervals between the eruptions of Kilauea the molten column rises towards the surface only to be lowered by subsequent eruptions. The subsidences, however, are not always accompanied by an outflow of lava upon the surface. At other times it may gush forth as a great fountain hundreds of feet or more in height, as if due directly to hydrostatic pressure.

That Mt. Mazama disappeared and the caldera originated through subsidence seems evident, but the corresponding effusion upon the surface, if such ever occurred, has not yet been found. It is hardly conceivable that 17 cubic miles of material, much of it solid lava, could collapse, be refused and sink away into the earth without a correlative effusion at some other point.

The bottom of the caldera is over 200 feet below the level of Klamath Marsh, which lies at the eastern base of the Cascade Range, and it is not to be expected that the point of escape would occur at any level above (4,200). This consideration would indicate that the effused mass should be sought on the western slope of

the range. The 4,200-foot contour, the level of the lowest portion of the lake bottom, occurs along Rogue River at a distance of less than 12 miles from the rim of the lake. The correlative lavas might perhaps be expected to be dacites closely related to the final flow of Mt. Mazama, but on Rogue River no such lavas were seen,—they are generally basalt; nor is there any suggestion of the escape of such an enormous mass of lava as recently as the time of the great collapse. Whether or not we are able to discover the corresponding effusion, there seems no reasonable doubt that Mt. Mazama was once a reality and that it was wrecked by engulfment.

J. S. DILLER.
U. S. GEOLOGICAL SURVEY.

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*THE TEACHING OF ANTHROPOLOGY IN THE UNITED STATES.**

THERE is a feeling among students of anthropology that official instruction in that field has not kept pace with the growth of societies and museums of anthropology, as well as with the ever-increasing volume of literature pertaining to the subject. A science which is rapidly filling our museums and now occupies so much space in current publications should have an exponent at every important seat of learning.

The past decade has, however, witnessed such rapid strides in the progress of anthropological teaching that fears for the future of this particular field of activity may, after all, prove groundless.

Nearly three years ago I began to collect information on the extent of instruction in anthropology in Europe and the United States. The results were embodied in a paper† that was read before Section H at the Columbus meeting, August, 1899, and which led to the appointing of a committee to consider ways and means of furthering instruction in anthropology in our own institutions of learning. The members of the original committee appointed by Vice-President Wilson were W J McGee, of Washington, chairman; Frank Russell, of Cambridge; and George Grant MacCurdy, of New Haven. Two additional members, Franz Boas, of New York, and W. H. Holmes, of Washington, were appointed later and, at the New York meeting in 1900, the committee of five was made a special committee of the Association, 'Committee on the teaching of anthropology in America.'

This committee is at present preparing a circular, the object of which is to set forth the aims, scope and importance of anthropology, as well as its place in higher education. At a recent committee meeting held in Washington it was decided that such a circular note, to be of the highest value, should be based on the latest and fullest information relative to the extent and trend of instruction in anthropology. Having already published one paper on the subject, I was appointed to bring that paper up to date so far as it related to the United States.

A circular note of inquiry was addressed to one hundred and twenty-one of our most important universities, colleges and medical schools. The number and character of the responses have been very gratifying. Of the one hundred and twenty-one institutions 31* offer instruction in anthropology, 36 do not, and 54 have not yet been heard from.

This is a vast improvement over the conditions which prevailed in 1899, so far as we had knowledge of them, as may be seen by comparison with the following table prepared two years ago:

* Read at Denver before Section H of the American Association for the Advancement of Science, August 29, 1901.

† SCIENCE, December 22, 1899, pp. 910–917.

* Including Phillips Academy, Andover, Mass.

Countries.	Institutions.	Professors.	Assistant Profe-sors.	Instructors, etc.	Total Teaching Force.	Faculties.
British Isles	4	1	0	8	9	Natural Science.
Germany	14	1	2	15	18	Philosophical.
France	4	11	0	1	12	Philosophical or Faculté des Lettres.
Italy	6	3	0	5	8	Philosophical; Nat. Sci.; Med.
Spain	1	1	0	0	1	Science.
Portugal	1	1	0	0	1	Philosophical.
Switzerland	2	0	1	1	1	Natural Science.
Austria-Hungary	3	2	1	1	4	Philosophical.
Russia	3	1	0	3	3	Natural Science.
Holland	3	0	0	3	3	Various.
Belgium	2	1	0	1	2	Medical.
Scandinavia	1	0	0	2	2	Philosophical.
United States	11	1	1	15	17	Various.
	55	23	5	55	81	

The details furnished by officers of their respective institutions are as follows:

BELOIT COLLEGE, BELOIT, WISCONSIN.

"A slight reference is made to anthropology in a one-hour course in American archæology throughout the sophomore year." This is elective and is offered by Dr. G. L. Collie, Professor of Biology and Curator of the Rust Museum.

BELLEVUE COLLEGE, BELLEVUE, NEBRASKA.

Anthropology is grouped with the history of civilization and sociology. Professor C. A. Mitchell gives a general sketch of anthropology in a three-hour course for one semester.

BOSTON UNIVERSITY, BOSTON, MASSACHUSETTS.

According to President Warren, while anthropology, in its newest developments and literature, receives incidental attention in a number of courses, no distinct course or courses are devoted to the subject exclusively.

BROWN UNIVERSITY, PROVIDENCE, RHODE ISLAND.

Anthropology is classed with zoology and geology and is taken as a senior elective. Professor A. S. Packard's general course includes the principles of ethnology, ethnography and prehistoric archæology.

The Museum of Anthropology in Rhode Island Hall contains a collection of 'articles of dress and rare implements from foreign countries, and valuable stone implements of the aboriginal races of America.'

CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS.

Anthropology is grouped with psychology and may be taken as major or minor for the Ph.D. degree.

Alexander F. Chamberlain, Ph.D., Acting Assistant Professor of Anthropology, offers two courses, twice a week throughout the year, besides theses, conferences and laboratory work. The general course embraces history, scope and relations of the science of anthropology, physical anthropology, ethnography, linguistics, criminal and pathological anthropology, historical and archæological. The special course is upon anthropological topics most akin to psychology and pedagogy.

During the month of July, Professor Chamberlain gave a course of twelve lectures on 'Education among Primitive Peoples' at the Summer School of Clark University.

COLLEGE OF PHYSICIANS AND SURGEONS, BOSTON, MASS.

Dr. John S. Flagg, Professor of Biology and Embryology and Lecturer on Anthropology, gives a series of 'optionally attended lectures, both general and special, on anthropology.' Besides, 'all matters of biology and embryology are treated from a more or less anthropological standpoint.'

COLUMBIA UNIVERSITY, NEW YORK CITY.

Anthropology is included in the Division of Philosophy and Psychology.

Franz Boas, Ph.D., Professor of Anthropology.

1. Ethnography. Lectures, essays and discussions.

2. Statistical study of variation, introductory course.

3. Physical anthropology. Lectures and laboratory work.

4. American languages.

5. Physical anthropology, ethnology, North American languages. Research work in conjunction with Professor Farrand.

Livingston Farrand, Ph.D., Adjunct Professor of Psychology.

1. Anthropology, general introductory course. Lectures, essays and discussions.

2. Ethnology—primitive culture.

COLUMBIAN UNIVERSITY, WASHINGTON, D. C.

There is a department of anthropology in the Corcoran Scientific School where students may choose the subject either as major or as minor for the degree of Ph.D. Professor Otis T. Mason, LL.D., of the U. S. National Museum, is the Director and offers the following courses:

1. Study of the races of man.

2. History of culture as embodied in the languages, industries, art, social life, philosophy and mythology of the various peoples of the earth.

3. Archæology and folk-lore.

Other professors whose courses bear more or less directly on anthropology are Daniel K. Shute, M.D., Anatomy; William P. Carr, M.D., Physiology; Mitchell Carroll, Ph.D., Classical Archæology; Andrew F. Craven, Ph.D., Sociology; Theodore N. Gill, LL.D., Zoology; Edward B. Pollard, Ph.D., Semitic studies; J. McBride Sterritt, D.D., Political Economy.

CREIGHTON UNIVERSITY, OMAHA, NEBRASKA.

Anthropology is studied as a division of mental philosophy and 'considered as a branch of primary importance.' Seniors devote one hour a week to the subject, which is in charge of C. Coppens, S. J., Professor of Philosophy.

DARTMOUTH COLLEGE, HANOVER, NEW HAMPSHIRE.

David Collin Wells, Professor of Sociology.

1. Anthropology and ethnology, introductory course, 54 exercises.

2. Anthropological geography. Man in relation to his physical environment, as determining his dispersal over the face of the earth, his mode of life, and the density of population. Fifty-four exercises.

3. Social statistics and applied sociology. The biological side of social life. Fifty-four exercises.

GEORGETOWN UNIVERSITY, WASHINGTON, D. C.

Anthropology is officially classed with psychology and is treated in the senior year and in the Graduate School. The Rev. Edward I. Devitt, S.J., Professor of Psychology, and the Rev. Timothy O'Leary, S.J., Professor of Philosophy, have charge of the work.

HARVARD UNIVERSITY, CAMBRIDGE, MASS.

Division of American Archæology and Ethnology, Courses in Anthropology.

Frederick W. Putnam, A.M., S.D., Professor and Curator of the Peabody Museum of American Archæology and Ethnology.

1. Special course in American archæology and ethnology. Museum, laboratory and field work. Theses.

Frank Russell, Ph.D., Instructor in Anthropology.

1. General anthropology. Lectures and theses.

2. Somatology. Lectures and laboratory work.
3. American archæology and ethnology.
4. Advanced somatology. Laboratory work and theses.

James H. Woods, Ph.D., Instructor in Anthropology.

1. Primitive religions. Lectures, reading and reports.

NATIONAL UNIVERSITY, WASHINGTON, D. C.

Thomas Wilson, LL.D., of the U. S. National Museum. Professor of Prehistoric Anthropology.

NEW YORK UNIVERSITY, NEW YORK CITY.

J. J. Stevenson, Professor of Geology, offers a course in anthropology, one hour a week throughout the year. The course 'covers the natural history of man, deals very little with ethnology and not at all with sociology.'

NIAGARA UNIVERSITY, NIAGARA COUNTY, N. Y.

Anthropology is treated as a branch of philosophy. The philosophy course extends over two years, of which time anthropology occupies about one sixth, or sixty hours. The Rev. P. J. Conroy is the instructor.

PHILLIPS ACADEMY, ANDOVER, MASS.

A Department of Archæology was recently established with a fund of $150,000 A museum is to be erected immediately. Dr. Charles Peabody, of Harvard, is honorary director and Mr. Warren K. Moorehead is curator. There are about 40,000 specimens with which to begin study. Dr. Peabody and Mr. Moorehead will give instruction after September, 1901.

OHIO STATE UNIVERSITY, COLUMBUS.

Mr. W. C. Mills, Curator, Ohio State Archæological and Historical Society, gives an approved course in anthropology which is open to all members of the University. More than 100 students have taken the course within the past two years.

UNIVERSITY OF CALIFORNIA, BERKELEY.

Professor W. E. Ritter, of the Department of Zoology, is preparing to give instruction in anthropology.

UNIVERSITY OF CHICAGO, CHICAGO, ILL.

Department of Sociology and Anthropology.

Frederick Starr, Ph.D., Associate Professor of Anthropology and Curator of the Anthropological Section of Walker Museum.

(*a*) Six courses for seniors, covering general anthropology, ethnology, prehistoric archæology and physical anthropology.
(*b*) Courses for graduates.
1. Mexico. Archæology, ethnology, physical anthropology.
2. New Mexico. Pueblo Indians.
3. Japan.
4. Laboratory courses in anthropology.

During summer quarters, two of the above courses are offered; in others, two courses in class work and laboratory work besides.

Merton L. Miller, Ph.D., Associate in Anthropology.

1. The races of Europe. Seniors.

William I. Thomas, Ph.D., Associate Professor of Sociology, gives a number of courses related to anthropology.

UNIVERSITY OF ILLINOIS, URBANA.

Dr. A. H. Daniels, Professor of Philosophy, gives a course in general anthropology, three hours per week for one semester.

Physical and psychical elements of ethnography. Origin of man. Races of mankind. Historical and comparative study of customs, ceremonies, rights beliefs and folk-lore of primitive peoples.

UNIVERSITY OF INDIANA, BLOOMINGTON.

Anthropology is officially classed with the Department of Economics and Social Science.

Ulysses Grant Weatherly, Professor of Economics and Social Science, offers two

terms' work, two hours per week. Physical anthropology, anthropometric work, race classification, etc. The origins of civilization and of society, with some study of American antiquities.

UNIVERSITY OF KANSAS, LAWRENCE.

Frank W. Blackmar, Professor of Sociology.

1. General anthropology, twenty weeks, five hours a week.
2. General ethnology, twenty weeks, five hours a week.

UNIVERSITY OF MINNESOTA, MINNEAPOLIS.

Samuel G. Smith, Lecturer in Sociology, treats incidentally of anthropology in his courses.

UNIVERSITY OF MISSOURI, COLUMBIA.

Charles A. Ellwood, Professor of Sociology.

One course in ethnology, three hours a week, throughout the year.

There is no course given in anthropology in the narrow sense of the term. The work in ethnology 'necessarily covers the subject matter of anthropology in a general way.' The work now offered is only elementary. Professor Ellwood will offer advanced work as soon as an assistant in anthropology and ethnology is appointed.

UNIVERSITY OF NEBRASKA, LINCOLN.

The reply of Professor Charles E. Bessey, Dean of the University, is quoted in full:

"As a separate subject it has no place as yet in the departments of instruction. Indeed, the word, 'Anthropology' does not occur in our Annual Calendar. Yet we have for years offered instruction in some of the topics which enter into scientific anthropology. Thus we have several courses covering the greater part of the field of somatology (in the department of zoology), and psychology (in the department of philosophy), as well as something of anthropology proper (in the departments of sociology and history). If these were to be brought together in one greater department the amount of anthropological work offered and actually taken by students each year would be found to be quite considerable. I estimate that during the year just closed fully 1,200 of the 2,200 students in the University pursued anthropological studies. If we were to bring these together they would make a department second only to that of English, which has about 1,800 students."

The instructors are Drs. H. B. Ward (Zoology); R. H. Wolcott (Physiology); Dr. A. B. Hill (Psychology, Logic, Ethics); Dr. E. A. Ross (Sociology); and Dr. F. M. Fling and Professor H. W. Caldwell (History).

UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA.

Faculty of Philosophy. Courses in ethnology and American archæology.

Stewart Culin, Lecturer and Curator of the Section of Asia and General Ethnology.

1. Outlines of North American archæology.
2. Comparative ethnology.

In order to systematize the work offered in archæology, Dr. Hilprecht, Professor of Semitic Philology and Archæology; Dr. Clay, Lecturer in Assyrian, Hebrew, and Semitic Archæology; and Dr. Bates, Lecturer in Greek and Classical Archæology have been associated with Mr. Culin in the administrative group entitled Archæology and Ethnology. The work is to be developed in connection with the Free Museum of Science and Art.

Progress is reported in the movement to found a 'Brinton Memorial Chair' of Anthropology at the University of Pennsylvania.

UNIVERSITY OF VERMONT, BURLINGTON.

Anthropology is grouped with natural and social science.

G. H. Perkins, Professor of Geology.

1. General course. Senior elective. A survey of the ethnological, social, moral and intellectual characteristics of the principal races of the world, followed by a discussion of the origin and development of laws, government, arts, industries, language, literature and religious systems.

Professor Emerson.

1. Social institutions.

UNIVERSITY OF WISCONSIN, MADISON.

Joseph Jastrow, Ph.D., Professor of Psychology, offers one course bearing on anthropology. It is entitled, 'Mental Evolution' and is based on Tylor's Anthropology.

WESTERN RESERVE UNIVERSITY, CLEVELAND, OHIO.

M. M. Curtis, Professor of Philosophy, gives a course of lectures on the history of anthropology, its main problems and bearings.

WILLAMETTE UNIVERSITY, SALEM, OREGON.

President Willis C. Hawley, Professor of Sociology, offers a course in anthropology for juniors and seniors consisting of text, lectures and assigned readings. Two hours a week for the year.

YALE UNIVERSITY, NEW HAVEN, CONN.

William G. Sumner, LL.D., Professor of Political and Social Science.

What Professor Sumner offers is described by himself as follows: "Somatic anthropology has no independent place in the undergraduate curriculum. It is taught as an adjunct to the social sciences by text-books and lectures. Two hours per week. Special students in the Graduate School have lessons in the subject as presented in Ranke's 'Der Mensch,' with lectures, other literature and museum illustrations." The last named course has hitherto been given on alternate years.

E. Hershey Sneath, Ph.D., Professor of Philosophy.

1. Philosophical anthropology. An outline study of man, his body and mind in their relations, his relations to nature, to his fellows, and to God.

Of the thirty-one universities and colleges offering anthropology, it is found to be an adjunct of sociology in nine, of philosophy in five, of psychology in three, of geology and zoology in five, and of medicine in one; while in five instances it stands practically alone and in three it is unclassified.

The process of differentiation has already taken place in the larger institutions and is destined to reach all at an early date. If about four fifths of those who are teaching the subject are impelled to do so because of its important bearing on their chosen field of work and because there is, at present, no one else to do it, they have a right to depend on being relieved of this additional burden by their own students, some of whom will specialize in anthropology and hold professorships where none now exists.

This seems to be the normal line of development and would of itself, in time, suffice to carry instruction in anthropology to every growing college and university in America. But there is evidence of forces at work which will serve to accelerate the general forward movement. An instance of this is the founding of a 'Department of Archæology' at Phillips Academy, Andover, Massachusetts, with two instructors, a collection of 40,000 specimens and funds to carry on the work.

No institution of higher learning, worthy of the name, can long afford to be without advantages which can be had at a first class preparatory school.

George Grant MacCurdy.
New Haven, Conn.

ON THE MEASUREMENT OF TIME.

In the period of the earth's rotation on its axis, called the sidereal day, Nature has provided a convenient, easily determined

and, for present purposes, practically invariable unit of time. For the subdivision of the day into the arbitrary units of time called hours, minutes and seconds, recourse is had to artificial mechanical devices known as clocks.

It may perhaps be stated in general, without serious danger of dispute, that the pendulum clock is the most accurate and reliable of all types of timekeeping mechanism. Chronometers have the advantage of portability and often run remarkably well for considerable periods of time, but they cannot compete with the pendulum clock in carrying an even rate during a series of months or years.

Yet a still higher degree of accuracy than that now prevalent in the performance of astronomical clocks is attainable, and is necessary in the present state of astronomy. There seems to be no reason why improvements in timekeeping should not take place along with the general progress in other directions, where scientific results depend on the perfection of mechanical appliances. The sidereal clock is one of the main features of an astronomical observatory, and if it is to continue to be used to measure the angular distance in right ascension between the fixed stars, greater uniformity in its rate than is now usual must be secured. It is also important in time service work to have clocks which will carry time with greater accuracy during long intervals of cloudy weather when observations of the stars cannot be made. The development of the pendulum clock dates from the time of Huyghens, the celebrated Dutch astronomer, who, in 1656, published his theory of the pendulum. From that time until the present the perfecting of the pendulum clock has received the attention of the best mechanical artists in Europe and America. Important improvements in clock-making were made early in the eighteenth century, when the mercurial compensation and dead-beat escapement were invented by Graham, of England. The gridiron pendulum, previously suggested by Graham, was soon after constructed by an Englishman named Harrison.

Excellent practical work was done a century later by a German named Kessels, of Altona, who improved the dead-beat escapement by modifying the form of the 'anchor.' The mechanical work of Kessels is remarkably fine. He made a clock for the observatory at Pulcowa in Russia, and another for the celebrated astronomer, Bessel at Königsberg. Bessel investigated the running of the clock with his usual thoroughness and was much pleased with it. He writes of Kessels as 'der kenntnissreiche und vorsichtige Kunstler.' Kessels also made a clock for the Naval Observatory in Washington, which, after running for half a century, is in perfect condition and is still giving good service.

Later Tiede, of Berlin, and Hohwü, of Amsterdam, attained great success in making astronomical clocks, and there are now two or three English and American makers who are doing work of great merit.

The Dennison gravity escapement, which has recently come into use, is supposed to be an improvement on the dead-beat escapement, because any small irregularity in the action of the train of wheels should theoretically have little or no effect on the pendulum. It should, for this reason, be better adapted for use in clocks provided with an electric contact, worked, as is usually the case, by a toothed wheel on the seconds arbor for transmitting signals for record on the chronograph. This is an important practical advantage, and to more certainly secure it, American clocks are usually made strong and heavy and are run with heavy weights. The relative merits as timekeepers of the best American and

German clocks is an interesting subject for investigation.

Within the last ten years a clock by Riefler, of Munich, having certain novel features, has come into notice. In the Riefler clock the pendulum rod is a tube filled with mercury by which the compensation is effected. The pendulum is perfectly free, except that it receives its impulse from the spring by which it is suspended. The Riefler clocks have given good results, and one of them has been adopted as the standard clock of the Pulcowa Observatory at Odessa in Russia.

Various devices have been used with success at Greenwich, Pulcowa and elsewhere for compensating clocks for variations of barometric pressure. A newly discovered alloy of 36 per cent. nickel with 64 per cent. steel, which has a remarkably small coefficient of expansion, makes it possible to compensate clocks more perfectly for changes of temperature.

The astronomical clock is a simple piece of mechanism and the perfection of design, excellence of workmanship and the efficiency of the various contrivances for compensating for variations of temperature and barometric pressure seem to have been developed to a point beyond which no great advance is to be expected along present lines. Even if the effects of change of temperature and air pressure on the pendulum could be perfectly eliminated by compensation, we should still have their effects on the clock train as well as the harmful influence of dust and moisture, unless the clock-case affords protection from the latter.

The most obvious chance for future progress seems to lie in securing the greatest possible uniformity of conditions. With a clock securely mounted, enclosed in an air-tight case and kept at an invariable temperature and barometric pressure, the only conceivable cause for variations in its rate would be perhaps the imperfections in the mechanism of the clock itself. It is necessary for obvious reasons that the sides of the air-tight case should be rigid. A constant pressure cannot be maintained without constant temperature, as may be seen from the well-known formula connecting the pressure, volume and temperature of a body of gas,

$$pv = kt,$$

in which, for our present purpose, v may be regarded as constant. We may therefore write,

$$p = k't.$$

In an air-tight case filled with air the change of pressure due to a change of temperature of 1° Centigrade is between 2 and 3 millimeters for pressures of 650 to 750 millimeters.

The first successful attempt to mount a clock in an air-tight case seems to have been made by Tiede, of Berlin, who in 1865 installed for Professor Foerster in the basement of the Berlin Observatory an electric clock in an air-tight glass cylinder. This clock, the escapement of which is a very simple piece of mechanism, is described by Professor Foerster in the 'Astronomische Nachrichten,' Nr. 1636. The impulses given to the pendulum are independent of the strength of the current, since they are produced by the falling of weights which are lifted each second by an electromagnet. The reason for adopting the electric clock was that the winding of a clock run by weights is attended by difficulties when the clock is enclosed in an air-tight case. While this clock does not run under ideal conditions, being subject to a gradual change of temperature and a consequent slight variation of barometric pressure during the year, it is probably the best time-keeper in the world. It has frequently run for periods of two or three months with such accuracy

that the average deviation of the mean daily rates for the whole period is only $0^s.015$ and with a maximum deviation of $0^s.03$. The clock was dismounted for cleaning in 1894 after running continuously for eight years. The pressure of the air in the case has been kept below the normal atmospheric pressure, and mention is made of the pressure having been made at one time as low as 180 mm., about 7 inches. Little difficulty seems to have been found in keeping the cylinder air-tight. Indeed a slight progressive diminution of the pressure in the cylinder has been observed, and is attributed by Professor Foerster to oxidation of the metal parts of the clock and to absorption by the glass walls of the cylinder of particles of moisture from the air within. This clock has been for thirty-six years the normal clock of the Berlin Observatory.

Soon after, Tiede succeeded in mounting a clock run by weights in an air-tight glass cylinder, and it was exhibited at the Paris Exposition of 1867. In his report of the Pulcowa Observatory for 1867 Otto Struve, the director, announced, with enthusiasm, Tiede's success, and stated that a clock run by weights and enclosed in an air-tight case had been ordered for that observatory. It appears subsequently that much difficulty was experienced from various causes in getting the clock into working order. But it was finally set up, about the year 1880, in the basement of the Pulcowa Observatory, where the temperature changes only four or five degrees a year, and was found to run with a satisfactory rate. This was for many years, and presumably is still, used as the principal clock of that observatory, which is an institution widely known for the high quality of its work. The pendulums of these clocks at Berlin and Pulcowa were compensated, of course, for change of temperature.

The Riefler clocks mentioned above are constructed so as to be easily mounted in air-tight cylinders, which together with the clock itself rest on a shelf bolted to the clock pier. There is one of these clocks mounted in the usual way at the Georgetown University Observatory at Washington. It is run by a weight which is wound up every few minutes by electricity. But it is not found practicable, under the conditions there, to keep the temperature strictly constant.

The standard clock of the Greenwich Observatory by Dent, of London, is mounted in the basement of the observatory, where the temperature changes are small and very gradual, and is fitted with an electrical device for barometric compensation.

The standard clock of the Paris Observatory, by Winnerl, enjoys the unique distinction of being mounted in a vault at a depth of 27 meters underground. The temperature changes at that depth are of course very small, being, according to Tisserand, not more than one or two hundredths of a degree during the year, but the effect of barometric changes on the rate of the clock has been found to be serious.

There seems to be no case where an attempt has been made to keep both temperature and barometric pressure strictly constant. There is, I think, no doubt that it is entirely feasible to maintain a suitably constructed vault at a practically constant temperature throughout the year by artificial means. Then, with an air-tight case, the barometric pressure could be kept practically uniform and the clock would be completely protected from dust and moisture. Even if it were not practicable to get the case perfectly air-tight, a practically uniform pressure could be maintained by exhausting the air from time to time, provided that the leakage is very small.

Accurate comparisons of clocks running

under such uniform conditions would be exceedingly valuable, not only in giving the highest order of results in timekeeping, but also in developing the peculiarities and comparative merits of the clocks themselves. The extreme accuracy with which two clocks, one keeping sidereal and the other mean time, can be compared by coincidences of the beats, which take place every six minutes, is familiar to every astronomer. Again, the more rapid minor variations in the rates of clocks could perhaps be detected and their periodicity determined by comparison with the vibrations of a pendulum swinging in vacuo.

Improvement in performance of astronomical clocks is of special importance in fundamental astronomy. An independent redetermination of the positions of the fundamental stars is necessary, and for this the most accurate possible timekeeping is needed because, in order to be of value in the present state of astronomy, such work must be of the highest degree of accuracy. All this has long been recognized by astronomers, and during the past forty years efforts in the direction of improved timekeeping have been made in all the principal observatories of Europe where fundamental work is attempted.

Commenting on the bad effect of variations in the rates of astronomical clocks due to the diurnal changes of temperature, Professor Foerster, the distinguished astronomer, who has been for 38 years director of the Royal Observatory at Berlin, wrote in 1867:

"How detrimental to accuracy such a large and changeable irregularity is, is evident since it operates like a variable division error.

"It is therefore necessary, in order that a clock may be of service in absolute determinations of star places, to have it protected from the daily temperature change, and also from all sudden changes of temperature. That is, it should be mounted in a place of nearly constant daily temperature so that it will remain for the compensation of the pendulum to effect only the last remaining fine adjustment.

"The air-tight confinement is safe in underground rooms or in heavy masonry against injury to the clock-work, because in the hermetically enclosed space any moisture present can be done away with by known means and the coming in of new moisture is impossible."

Milton Updegraff.
U. S. Naval Observatory,
Washington, D. C.

SCIENTIFIC BOOKS.

The Stars, A Study of the Universe. By Simon Newcomb. Pp. v+333. New York, G. P. Putnam's Sons; London, John Murray.

This is professedly a book written to order, as a part of the science series now appearing under the editorial supervision of Professor Cattell, and its author states plainly in his preface that he has found the task, 'to sketch in simple language for the lay as well as the scientific reader the wonderful advances of our generation in the knowledge of the fixed stars,' much more onerous than he had anticipated, on account of 'the extent and complexity of the subject and the impossibility of entering far into technical details in a work designed mainly for the general use.'

If one may judge the extent of systematized knowledge concerning the fixed stars by the space allotted to its presentation in the most approved text-books of general astronomy, from that of Arago to the present time, it appears that this branch of astronomy has grown during the century from about one eighth to one sixth part of the entire science. But the indexes to recent volumes of the principal astronomical periodicals show that about one-third of the articles there appearing relate to problems of stellar astronomy and thus mark an accelerated growth of interest in and knowledge of the remoter parts of the visible universe. The author who attempts to digest

this rapidly accumulating material and to present its substance in untechnical form merits the thanks of both professional and lay readers, even though occasional inaccuracies or omissions affect the text or the rapid advance of knowledge renders obsolete some passages before the ink is dry upon the pages. A double acknowledgment is due when, as in the present case, that author is the one astronomer marked out by long and distinguished service in important parts of this field as peculiarly adapted to the task. The title, Retired Professor U. S. Navy, that follows the author's name upon the title page, suggests thoughts far from complimentary to that fatuous governmental policy in accordance with which astronomers are retired from the public service upon reaching an age limit not far removed from the maximum of intellectual power.

In substance, though not in formal arrangement, the present work falls naturally into two parts; first, a description of methods of research and such elementary classification of stars as are the familiar province of the better text-books, *e. g.*, the grouping of stars into constellations, the explanation of stellar magnitudes, proper motions, parallaxes, stellar spectroscopy, the description of the phenomena presented by variable and double stars, nebulæ, etc.; and second, a more original part devoted to the larger problems of stellar distribution, the significance of the milky way, the sun's motion, stellar evolution and similar matters which may be grouped, fairly enough, under the title, the structure of the heavens. We welcome here a presentation of some of Kapteyn's results not hitherto accessible, of Huggins's views of stellar evolution, and the author's own methods, inferences and conclusions from the new material collected and sifted in the preparation of this work. As types of these last-named categories it is interesting to note the simple statistical method (p. 300) by which certain results first obtained by Kapteyn through an elaborate and tedious mathematical process are independently derived. Of a very different order is the suggestion made with reference to Bailey's discovery of variable stars in clusters, that there is 'a strong presumption that the variations in the light of these stars are in some way connected with the revolution of bodies round them, or of one star round another.' The distribution of the stars in space is treated with a fullness of detail that occasions some surprise at the almost complete neglect of a possible absorption of starlight in the interstellar spaces; a possible defect of transparency in the celestial void, that has been rendered a classic theme by Struve's speculations and more recently has been elaborated by Schiaparelli.

Taken as a whole the work contains in excellent form a large amount of material interesting to the professional astronomer and in even larger measure valuable to the popular expositor of astronomy, teacher, lecturer or writer. As it is sure to be largely drawn upon by this class it seems important to eliminate as rapidly as possible those errors and inaccuracies inseparable from a first edition, among which we note the following:

P. 158, line 10, for eleven read five and one-half.

P. 182, line 3, for Triphid read Trifid.

P. 194, insert a^3 in the numerator of the fraction.

P. 198, line 1, for $2m$ read 2^m.

The statement made on p. 179 with regard to the Orion nebula, 'This is plainly visible to the naked eye and can be seen without difficulty whenever the constellation is visible,' does not at all correspond to the experience of the present writer who has great difficulty in seeing the nebula with unaided vision, even under favorable circumstances, and whose experience is shared by a dozen young people, of both sexes, who at his request have looked for the nebula.

In the matter of nomenclature some objection may fairly be raised to the apparently needless introduction of new terms in place of the familiar old ones, such as the logically inappropriate, apocenter, pericenter, for apastron, periastron, in connection with double star orbits, and the rechristening of the Fraunhofer lines of the solar spectrum as Wollaston lines. But with all due allowance for such minor blemishes the book remains in its entirety a notable contribution to the literature

of astronomy. Its style is clear and attractive and the illustrations, some excellent, are in the main adequate although many of the diagrams are disagreeably crude. A familiar literary device, that of prefixing a brief metrical introduction to each chapter, has here been so felicitously applied as to deserve especial mention. An excellent table of contents and index greatly facilitate the use of the work as a book of reference. George C. Comstock.

EARTH-CURRENT OBSERVATIONS IN THE GERMAN TELEGRAPH SYSTEM.*

The origin of these important observations dates back to 1881, when a committee was called together by Werner Siemens, to study the phenomena of earth-currents. Through their efforts, two underground cables were provided by the Imperial Telegraph System, one running in an easterly direction from Berlin to Thorn, 262 km., the other nearly due south from Berlin to Dresden, 120 km. The present work deals chiefly with the continuous observations of earth-currents from these two lines, from 1884 to 1888. The Prussian Academy of Sciences assisted, in part, in the maintenance of the observations.

The assumption is made at the start that the observed currents are due to potential differences between the ends of the lines; that is, they are derived from currents that flow in closed circuits within the earth, parallel to its surface. Of course *vertical* differences of potential have to be left out of consideration.

The attempt to express the intensities in the two lines by trigonometrical formulæ according to Gauss, using the latitude and longitude as variables, leads to equations whose constants are too difficult to be determined. Assuming the validity of Ohm's law, however, the intensity of the earth-current components in the two directions may be given by the equations

$$J = A\frac{W}{L}i, \quad J' = A\frac{W'}{L'}i',$$

where A is a constant and W, W' are the resistances, L, L' the lengths and i, i' the observed current strengths in the two lines respectively.

We thus obtain for the total earth-current,

$$E = A\sqrt{\frac{W^2}{L^2}i^2 + \frac{W'^2}{L'^2}i'^2}.$$

The value of the constants was computed for each of the two lines. The results are only relative, however, as no reductions to absolute units were made.

The most characteristic feature of earth-current variations is their dependence upon the position and condition of the Sun. The diurnal and annual variations are especially marked. In view of this, the attempt is made to modify the trigonometrical representation in such a way as to use, instead of the latitude, the angle with the Sun's declination, and for the longitude, the local time or the right ascension of the Sun. The results indicate, however, as was to be expected, that this is not sufficient, but that other factors have to be considered. In general there can be distinguished a constant component of the current, due to terrestrial and local conditions, and a variable component, depending chiefly upon the Sun. The four years of observations were not enough to make the derivation of accurate formulæ possible. As approximations, however, expressions for the components in the two directions were derived, as functions of the local time and its multiples, from which the diurnal variation is made evident.

The self-recording instruments were of two different types. In the Berlin-Dresden line a Siemens 'Russschreiber' was used, in the other line a mirror-galvanometer reflected a beam of light on to photographic paper. The sensitiveness of both instruments was frequently determined, and though the results were not reduced to absolute measure, still it is always possible to get accurate relative values between the two lines.

The magnetic records, which, as the title indicates, formed an essential part of the work, were obtained chiefly from the observatories at Wilhelmshaven and Vienna, but to a lesser extent also from the observations during the

* Die Erdströme im deutschen Reichstelegraphengebiet und ihr Zusammenhang mit den erdmagnetischen Erscheinungen, bearbeitet und herausgegeben von Dr. B. Weinstein. Braunschweig, Friedrich Vieweg & Sohn, 1900.

international polar year 1882–3 made at Kingua-Fjord, South Georgia and Fort Rae.

The discussion of the earth-currents is based upon the tabulated hourly ordinates from the curves. Instead of measuring a single ordinate for each hour, a planimeter was employed, covering a region on each side of the ordinate sought. A further reduction, by means of trigonometric series, was carried out, in order to get a still closer approximation to the true hourly values.

The diurnal variation of the earth-currents was well marked, showing two principal maxima, and two secondary. An examination of the equations for the mean diurnal variation for the different years shows a slight systematic change from year to year. The mean variation for each year is prettily shown in the excellent vector diagrams, which are a feature of the work. All of the curves show a motion in the direction of the hands of a watch, and in the details of configuration the agreement is also good. A number of interesting deductions are drawn, indicating the dependence of the phenomena upon the Sun's position.

This dependence is no less clearly shown by the annual change in the diurnal variation. A principal maximum of current intensity occurs at the time of the vernal equinox, a secondary one at the summer solstice. The principal minimum is at the winter solstice. The east-west and south-north components for the diurnal variation are very similar throughout the year. As the Sun moves north, the principal waves in the diurnal variation become more pronounced, the secondary waves less so. In winter the reverse is the case, making the winter curves the more complicated. Similar fluctuations are shown in the coefficients of the trigonometrical representation, as well as by a series of vector diagrams for the months and the seasons. The latter are particularly interesting, showing that the mean current in winter is only about half as strong as in summer. Changes of a few days' duration in the character of the curves also occur frequently, which the author attributes to the varying relative position of nonhomogeneous portions of the Sun, with reference to the earth.

A patient study was made of the diurnal variation, bringing to light the existence of 36 secondary waves in the course of a day. These occurred about 11 minutes later in the north and south than in the east and west line. The exact number of wavelets may be open to doubt, for the personal equation carries great weight in such investigations; but at least the existence of a system of regularly occurring secondary waves seems established.

The second part of the work is devoted to a discussion of the magnetic records from the stations already mentioned, and the connection between them and the earth-currents. The method of treatment is essentially the same as with the earth-currents, the three rectilinear components of the total intensity being considered. A study of the diurnal variation by means of vector diagrams reveals a more or less definite connection with the Sun's motion. In discussing the direction of the variation, two systems of coordinates are used: First, the 'geopolar,' given by the hour-angle and latitude of the point where the direction at any hour cuts the Earth's surface; and second, the 'heliopolar,' in terms of the angle with the Sun's direction (heliopolar distance), and the angle which the plane through the direction at any hour and the Sun makes with the equator. The track of the diurnal variation upon the Earth's surface is described in detail, and shows interesting similarities between the different stations. The vector diagram of the total variation is also resolved into components in the directions of the planes of the equator, the meridian, and a plane perpendicular to both; in each case the dependence upon the Sun's position is well marked. The vector diagram in heliopolar coordinates takes the form of a conical surface around the Sun. The variation vector sometimes makes an angle as great as 90° with the direction of the Sun, but never points directly toward it, from which the conclusion is drawn, that if the Sun is the cause of the variation, the influence can not be exerted along a straight line from the Sun to the Earth. We must pass over the many interest-

ing details in the results from the different stations, merely noting that the vectors for the diurnal variation at Fort Rae move in a direction opposite to that at all other stations.

The study of the course of the magnetic variation throughout the year makes it appear that all phenomena occurring in any one season in the southern hemisphere do not, as was formerly supposed, correspond to those of the opposite season in the northern; on the contrary, certain features in the yearly variation seem to indicate the presence of influences outside the Earth, affecting the Earth as a whole. The dependence of the variation upon the latitude of the station is brought out with great clearness.

The above results have an important bearing upon Schuster's theory of the diurnal variation. This theory, as von Bezold has pointed out, requires an *invariable* system of forces, in whose field the Earth rotates. Weinstein's deductions show that excessive deformations of the system would be needed to account for some of his observed phenomena, so excessive, in fact, as to lend strong evidence in favor of local influences. We must therefore assume at least two systems of forces, one external, possibly subject to variations, the other of local character.

This part of the work concludes with a discussion of secondary magnetic waves, of which, for Wilhelmshafen in 1884, a mean of 36 were detected in the course of a day, in the case both of declination and of horizontal intensity. The connection between waves in the two elements could not however be established with certainty. It is at least significant that the number of secondary waves here is the same as in the case of the earth-currents.

The work reaches its culmination in Part III., where the relation between terrestrial magnetism and earth-currents is discussed. We regret that space does not permit a more extended review of this interesting chapter. To test first the hypothesis that the earth-currents are simply inductive currents caused by changes in the Earth's magnetism, the author compares the mean diurnal variation in vertical intensity for Vienna in 1884, with that of the earth-currents for the same year. Instead of maxima in increase of vertical intensity corresponding to maximal current, etc., we find almost the reverse to be the case. The author therefore confines himself to the question whether variations in magnetism are partly due to the earth-currents. If the *vertical* component of the current changes were known, the problem would be much simplified; in lieu of this, ingenious methods have to be resorted to in order to gain such circumstantial evidence as is possible. Even in a horizontal direction only the mean components for certain distances in two directions are known, while the true path of the current lies wholly in the dark. An increase in one or both of these components would not of necessity cause an increase in any one of the magnetic elements, since any such effect might be more than counterbalanced by changes in the direction of the earth-current.

A comparison of the mean absolute values of vertical magnetic intensity and earth-current intensity for the 24 hours tends to strengthen the theory. To explain certain peculiarities in the former, assumptions are made concerning the variation in direction of flow of the earth-currents, which in turn would require an increase in the magnetic horizontal intensity; and this increase is in fact found to take place. When the changes in azimuth of the horizontal components of earth-current and magnetic intensity are compared, the evidence is weaker, though still in the same direction. The comparison of changes from season to season is also favorable, certain minor variations agreeing remarkably well.

As concluding evidence, reference is made to the parallelism in the occurrence of sudden disturbances. By picking these out on the declination traces in Vienna and comparing them with corresponding disturbances on the Berlin earth-current records, the difference in longitude between the two cities could be quite accurately determined. A rigid comparison would of course be possible only if both direction and amount of the resultant disturbances were known, which is far from being the case in the present state of the science.

The author states his conviction that almost the whole of the variations observed by magnetometers are due to earth-currents which act upon the instruments as upon galvanometers. An immense amount of patience and skill has been devoted to the compilation of results, and it must be admitted that the evidence is favorable to this theory. As a working hypothesis it may be found of great value; but our knowledge of the phenomena, and particularly the mass of actual observations, must be vastly extended before we can finally accept the solution as a physical fact.

W. G. CADY.

U. S. COAST AND GEODETIC SURVEY,
MAGNETIC OBSERVATORY, CHELTENHAM, MD.,
December 21, 1901.

The Birds of North and Middle America: A Descriptive Catalogue of the Higher Groups, Genera, Species and Subspecies of Birds known to occur in North America, from the Arctic Lands to the Isthmus of Panama, the West Indies and other Islands of the Caribbean Sea, and the Galapagos Archipelago. By ROBERT RIDGWAY, Curator, Division of Birds, U. S. National Museum. Part I. Family Fringillidæ—The Finches. Washington, Government Printing Office. 1901. Bulletin of the United States National Museum, No. 50. 8vo. Pp. xxxii + 715, pls. 20.

The geographical scope and general character of this important work is well indicated by the above transcript of the title-page, which does not, however, give an adequate idea of the amount of labor involved in its preparation, which has largely engaged the author's attention for the last twenty years, and for the last six years has occupied the greater part of his time. The present volume is the first of the series of eight required to complete the work, averaging about 800 pages and some twenty plates to each volume. As much of the drudgery of collating references, and taking measurements, for the 3,000 species and subspecies comprised in the work, has been mostly completed, it is expected that the publication of the remaining volumes will proceed with little further delay.

The present volume treats only of the single family Fringillidæ, or Finches, which number 389 species and subspecies, of which about one-half occur in North America, the rest being exclusively birds of 'Middle' America. The introductory matter comprises an appropriate dedication to the late Professor Baird, followed by a preface of seven pages, stating the principles that have guided the author in his work, with other explanatory matter. The author has to regret the necessity of beginning his work with the highest instead of the lowest forms, owing to the lack of adequate facilities for arranging the collection of birds in the National Museum, the larger birds being inaccessible for study. This state of affairs has existed for some ten to fifteen years, greatly to the regret and inconvenience of many ornithologists besides the curator, and affords a striking commentary on the neglect by the government of our great but inadequately housed National Museum.

The first twenty-five pages of the main text are devoted to a critical consideration of the classification of the class Aves, with diagnoses and keys for all the higher groups, and for the families of the Oscines. His system is admittedly eclectic, but is on the whole a quite satisfactory compromise. The Fringillidæ, as defined by Mr. Ridgway, embrace several finch-like genera usually referred to the Tanagridæ, but which seem to fit better as members of the Fringillidæ; yet, with these transfers, there is still no hard and fast line of division between the two groups.

Mr. Ridgway's work is strictly systematic and technical. Aside from the descriptions of the forms, the elaborate keys, and the statements of range, a special feature is the very full bibliographical citations, which constitute a large part of the text, and include all references of any value, thus forming an index to the literature of each species. The locality to which a citation relates is stated whenever possible, thus greatly facilitating the labors of future workers. In compiling the references extreme exactness has been attempted in all matters of orthography and nomenclatural combinations—a feature often neglected, but of the highest importance. As Mr. Ridgway

observes: "Anyone who has had occasion to verify citations must know that the amount of inaccuracy and misrepresentation in current synonymies, even the most authoritative and elaborate, is simply astounding. They abound with names which do not even exist in the works cited, with those which do not correspond with the originals in orthography, with others that have no use or meaning whatever, being evidently culled from indices without reference to what their status may be on the pages indicated."

In matters of nomenclature the author has followed the American Ornithologists' Union 'Code of Nomenclature,' which has 'been strictly adhered to in all respects.' He has, however, reached different conclusions, in a few cases, regarding the status of certain forms, from those of the A. O. U. Committee. Considering the large amount of time he has been able to give to such points, aided by access to all of the available material, the benefit of the doubt may be safely permitted to rest with Mr. Ridgway, till some equally competent expert, with superior resources, reverses his conclusions.

The 20 plates give outline figures of the bill, feet, tail and wings of each genus treated, and are thus a valuable aid to the student. The work in all its details shows the author's characteristic and well-known thoroughness of treatment, and ornithologists the world over will wish him health and strength to complete the enormous undertaking involved in the preparation of the 'Birds of North and Middle America.'

J. A. A.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for January begins with an article on 'Prehistoric Hafted Flint Knives,' by Charles C. Willoughby, describing various forms of these implements; Douglas H. Campbell discusses 'The Affinities of Certain Anomalous Dicotyledons' and J. H. Comstock and Chujiro Kochi present a long and careful study of 'The Skeleton of the Head of Insects,' using the known facts of embryology to give a clearer idea of the structure of the head, attention being mainly given to representatives of the more generalized orders of insects. The article is well illustrated and a long list of references is appended. R. W. Shufeldt contributes a paper 'On the Habits of the Kangaroo Rats in Captivity,' and under the title 'A Contribution to Museum Technique' S. E. Meek describes the method of mounting fishes for exhibition in flat jars, the specimens being hardened in alcohol, then painted with water-colors and then replaced in alcohol.

The Plant World for December, 1901, contains 'Farther Notes on Trees of Cuba,' by Valery Havard, with a fine plate of the silk cotton tree; 'Notes on the Pan-American Exposition,' by Pauline Kaufman, in which we are sorry to see an account of a 'petrified body'; 'The Flora of Snow Cañon, California,' by S. B. Parish, besides the customary Briefer Articles, Notes and Reviews. In the Supplement Charles L. Pollard continues the description of the families of the order Parietales.

The Museums Journal, of Great Britain, contains a brief biographical sketch of Dr. Henry Woodward, who has just retired from the keepership of the department of geology in the British Museum. J. G. Goodchild describes, under 'Astronomical Models in Museums,' a practical orrery on a rather large scale devised by him for the Edinburgh Museum of Science and Art, and D. P. H. discusses 'Hygiene as a Subject for Museum Illustration,' giving an outline of the method and objects of such an exhibit. There are a few short articles and numerous notes on Museums in various parts of the world.

The American Museum Journal for November–December continues L. P. Gratacap's paper on 'The Development of the American Museum of Natural History,' and deals with the department of vertebrate palæontology. Other articles deal with recent work of the Museum, and the number has a well-illustrated supplement on 'The Saginaw Valley Collection,' by Harlan I. Smith, which is to serve as a visitors' handbook.

Following the death of Dr. Charles Henry Brown, the former proprietor of the *Journal*

of Nervous and Mental Diseases, Dr. Smith Ely Jelliffe of New York has become the responsible editor. Dr. William Osler, Dr. Frederick Peterson and Dr. Wharton Sinkler have joined the advisory board. Dr. William G. Spiller of Philadelphia will continue to be acting editor.

SOCIETIES AND ACADEMIES.

THE AMERICAN PHYSICAL SOCIETY.

THE Annual Meeting of the Physical Society was held at Columbia University on Dec. 27, 1901. From some points of view the date was an unfortunate one, coming as it did so soon after Christmas day. But in spite of this fact the attendance was unusually good, while the program included a larger list of papers than that of any previous meeting except the one held in connection with the New York meeting of the American Association in 1900.

Officers were elected for the year 1902 as follows:

President, Albert A. Michelson; *Vice-President,* Arthur G. Webster; *Secretary,* Ernest Merritt; *Treasurer,* William Hallock.

Messrs. Carl Barus, D. B. Brace and A. L. Kimball were elected members of the Council of the Society.

The following papers were read:

'A Suspected Case of the Production of Color by the Selective Electrical Resonance for Light Waves of Very Minute Metallic Spheres': R. W. WOOD.

'Report on Electrostriction': LOUIS T. MORE.

'Further Experiments on Electrostriction': J. S. SHEARER.

'The Transmission of Excited Radioactivity': E. RUTHERFORD.

'Excited Radioactivity and Ionization of Atmospheric Air': E. RUTHERFORD and S. J. ALLEN.

'Note on Drude's Elektronentheorie': E. H. HALL.

'The Disturbances of a Plumb-bob suspended on a Steel Wire': WM. HALLOCK.

'A Thermograph for Earth Temperatures': WM. HALLOCK.

'The Viscosity of Water determined by the Aid of Capillary Ripples': F. R. WATSON.

'Magnetization of Steel at Liquid Air Temperatures': C. C. TROWBRIDGE.

'The Pfanndler Calorimeter': W. F. MAGIE.

'Standards of High Electrical Resistance': H. C. PARKER.

'Variation of Contact Resistances with Change of E. M. F.': H. C. PARKER.

'On a Ruling Engine for Diffraction Gratings': A. A. MICHELSON. (Read in abstract by the Secretary.)

The next meeting of the Society will be on Feb. 22, at 10:30 o'clock A. M., in Fayerweather Hall, Columbia University.

ERNEST MERRITT,
Secretary.

OHIO STATE ACADEMY OF SCIENCE.

THE eleventh annual meeting was held at Columbus, November 29 and 30. This was a month earlier than the usual time but the attendance was as good as usual, about thirty-five. The policy of holding a summer field meeting every year the Academy decided to abandon. Some of these meetings have proved very successful, but of late the attendance of members living at a distance has been small, except when held in connection with the meeting of some other organization. Hereafter the executive committee each year may or may not call a summer meeting.

The following resolution was passed: "That the Academy, through its secretary, respectfully represent to the postal authorities that the present provisions and rulings of the postal department regarding transmission of natural history specimens are inconsistent and a serious hindrance to exchange of scientific material and urge that better provisions be afforded."

The secretary read obituary notices of Edward W. Claypole, first president of the Academy, and of Mrs. Claypole, and a committee was appointed to draft a suitable memorial.

A letter was read from Emerson E. McMillin, again placing $250 at the Academy's disposal. Eighteen persons were elected to membership.

The topographic survey of Ohio by the U. S. Geological Survey in cooperation with the State was begun in 1901 as a result of determined efforts put forth by the Academy of Science beginning in 1896, when Albert A.

Wright made the matter the subject of his presidential address. The progress of the topographic survey during the past season was described by C. N. Brown. The report of the Committee on Topographic Survey, prepared by Albert A. Wright, the chairman, was read by Lynds Jones. In conclusion it says: "It is very desirable that the members of the Academy and all other supporters of the survey, should make known, to their representatives in the legislature and to the governor and other officers of the State, their desire that this work, so well inaugurated, should be followed out to its completion, in the mapping of the entire area of every county of the State."

The following officers were elected for the ensuing year: President, W. R. Lazenby; Vice-Presidents, C. J. Herrick and C. S. Prosser; Secretary, E. L. Moseley; Treasurer, Herbert Osborn; Elective Members of Executive Committee, Wm. Werthner and John Uri Lloyd.

The program was as follows:

'New Fossils, including Sea-weeds, two new genera, Carboniferous, Marietta; Land Plants, two species, Carboniferous, one species, Corniferous; Corals, fifteen Cyathophylloids, Corniferous; Brachiopods, one, Corniferous; Cephalopods, six, Corniferous': H. Herzer.

'Notes on the timber of trees of Ohio': William R. Lazenby.

'The self-pruning of woody plants': John H. Schaffner.

'The Ohio species of *Phyllachora*': W. A. Kellerman and J. G. Sanders.

President's Address—'The Future of Vegetable Pathology': A. D. Selby (will be published in Science).

'A striking case of mimicry, with exhibition of specimens': Herbert Osborn.

'Smut infection experiments': W. A. Kellerman and O. E. Jennings.

'Further observations on the preglacial drainage of Wayne and adjacent counties': J. H. Todd.

'The weight, waste and composition of apples': William R. Lazenby.

'Plant ecology of Ohio; a general outline': John H. Schaffner and Fred. J. Tyler.

'Observations on the flora of the Gauley Mountains, West Virginia': W. A. Kellerman.

'Preliminary list of tamarack bogs in Ohio': A. D. Selby.

'Report for 1901 on the State Herbarium with additions to the Ohio Plant List': W. A. Kellerman.

Joint Meeting of the Academy of Science and the Modern Language Association of Ohio. (Three titles.)

'Modern Languages and Science in High School Course': William Werthner.

'Botanizing in the Colorado Mountains'—Illustrated: A. D. Selby.

'Some notes on a trip to southeastern Siberia': Gerard Fowke.

'Notes on Hemiptera with some records of species new to the Ohio list': Herbert Osborn.

'Observations on some South American Hemiptera, with exhibition of specimens': Herbert Osborn.

'A species of Diptera mining the leaves of wild rice at Sandusky': Jas. S. Hine.

'Experiments with chemicals to improve seed germination': W. A. Kellerman and F. M. Surface.

'A possible cause of Osars': G. H. Colton. Read by the secretary.

'The introduced species of *Lactuca* in Ohio': A. D. Selby.

'Gradations between *Verbena stricta* and *Verbena angustifolia*': Thos. A. Bonser.

'New plants for the Ohio Catalogue': A. D. Selby.

'Observations on the origin of forest belts in Clay County, Kansas': John H. Schaffner.

'A report on the Revised Catalogue of Ohio Birds': Lynds Jones.

'The summer birds of Lake Erie's Islands': Lynds Jones.

'Perverted Benevolence': Gerard Fowke.

'Notes on *Anthurus borealis* and *Erysiphe graminis*': W. W. Stockberger.

'Report on Ecology of Big Spring Prairie': T. A. Bonser.

'Some aspects of plant growth as illustrated by methods of watering': W. J. Green. Presented by the president.

Shall we continue the field meetings?

What places of interest to scientists or to the general public are in need of protection by the State?

In what manner may the Academy become more serviceable to the scientific interests of the State?

'An insect pest new to Ohio': F. M. Webster. Read by title.

'The trend of insect migration in America': F. M. WEBSTER. Read by title.

'A plasmodium found in the blood of a turtle and related to the plasmodium of malaria': C. B. MORREY. Presented by Herbert Osborn.

E. L. MOSELEY,
Secretary.

NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

A REGULAR meeting of the Section of Biology was held on January 13, Professor Charles L. Bristol occupying the chair. The following program was presented:

1. 'The Relation between the Variability of Cells and that of Organisms': FRANZ BOAS.

2. 'Degeneration in *Paramœcium* and so-called Rejuvenescence without Conjugation': GARY N. CALKINS.

3. 'Natural Selection in *Samia cecropia*': HENRY E. CRAMPTON.

Professor Boas, in his paper, which has been printed in full in SCIENCE for January 3, 1902, established the following conclusions: "(1) The elements of organisms are more variable than the organisms themselves. (2) The elements of organisms vary in correlated groups. (3) The characteristics of the variability of an organism depend upon the correlations of its constituent elements, so that a knowledge of these correlations will enable us to determine the characteristics of the variability of the organism." (4) It was also pointed out that skew distribution of variations does not necessarily indicate selection, or instability of type, but may occur in stable forms.

Dr. Calkins presented the history of two individuals, *A* and *B*, of *Paramœcium caudatum*, from different localities, which were isolated February 1, 1901. These were fed on twenty-four hour hay-infusion, and the number of divisions recorded at periods of from one to three days throughout the year, one individual being isolated each time. Conjugation occurred for the first time, among the extras, in May. This period was followed, in July, by well-marked degeneration of both *A* and *B*, which went so far that nearly all of the stock was lost. The survivors were stimulated to renewed activity by treatment with extract of lean beef. After three months of normal and active divisions, another period of conjugation occurred. This again was followed by degeneration and again the cultures were saved by treatment with beef-extract. At the present date (January 13), *A* is in the 416th generation, and *B* in the 375th generation, and no conjugation has taken place in the direct line of the cultures. Thus far the experiments have yielded the following results: (1) *Paramœcium* unquestionably passes through more or less regular cycles of activity and weakness. (2) The period of weakness is preceded by one of greater dividing activity. (3) The period of weakness ends in death, provided the diet (hay-infusion) remains the same. (4) Beef-extract, without conjugation, restores the weakened functions of growth and division. (5) Exogamous conjugation of *A* and *B*, if followed by the same diet (hay-infusion), does not restore these weakened activities, but is soon followed by death. (6) Exogamous conjugation between wild gametes, and followed by hay-infusion diet, results in normal growth, division, and life. (7) Endogamous conjugation among gametes from the cultures does not differ from exogamous conjugation. The ex-conjugants live and divide normally if fed for a time with beef-extract, but die if fed directly with hay-infusion. (8) One intra-cellular effect of beef-extract upon weakened *Paramœcium* is the formation of 'excretory granules.' Another is the disintegration of the old macronucleus. (9) A few conclusions to be drawn are: (*a*) a change of diet is necessary for the continuance of vital activities; (*b*) the equivalent of parthenogenesis in higher animals may be induced by change in diet; (*c*) conjugation, by itself, does not 'rejuvenate'; (*d*) conjugation probably has some other significance than that usually accepted, though what this significance may be is not indicated, thus far, by the experiments.

Professor Crampton presented the results of a statistical study upon pupæ of *Samia cecropia*. Twenty-five characters were determined for a lot of 456 pupæ, the measurements were tabulated, and the usual constants of the curves of variation were ascertained, viz., the

range, mode, mean, standard deviation and coefficient of variability. It was found that only 349 of these pupæ produced perfect moths at the time of metamorphosis, the others being imperfect to a greater or less degree, and therefore presumably ruled out as far as reproduction is concerned. When, now, the former class was compared, sex by sex, with the whole group of pupæ, it was found to be a selected class of the less variable individuals, while the more variable ones were eliminated. Selection is therefore 'periodic' in the sense of Pearson. The fact of primary interest appears when this case is contrasted with that of *P. cynthia*. As reported last spring, selection in the latter species is similarly of the less variable individuals, but is 'secular' as well, that is, the perfectly metamorphosing pupæ form a class by themselves, with a type which differs from that of the whole group. It was pointed out that the real basis of selection was probably a correlative one, a physiological 'fitness' depending upon the proper coordination or correlation of the various parts of the organism.

Henry E. Crampton,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

The Section met at the Chemists' Club on the evening of January 6. Mr. H. C. Parker gave the results of some experiments he had made on the 'Variation of Contact Resistance with Change of Electromotive Force.' The resistances used in the experiments consisted of oxide of manganese on cobalt glass, the new form of standard high resistance described in a previous paper given before the Academy. The electromotive forces employed consisted of 10, 50 and 100 dry cells, respectively. It was found in every case that the resistance decreased with increase of electromotive force. This decrease might be only a small percentage, or the resistance might be reduced to a small portion of the original value. Improving the contacts rendered this change in resistance much less marked. It was stated that the decrease in resistance when the electromotive force was increased might possibly be due to a kind of coherer action taking place at the contacts. Very high resistances, measured by the electrometer method, were found to practically obey Ohm's law. It was pointed out that in such cases the contact resistance was probably only a small portion of the entire resistance.

Professor Hallock presented a paper on the 'Magnetic Deflection of Long Steel Wire Plumb-lines.' He stated that in the course of the work in the very deep shaft of the Tamarack Mining Co. on Lake Superior it had been found desirable to plumb down certain points from the surface. The plumb-lines used were of No. 24 piano wire and the weights were fifty pounds of iron. At first the lines were 16.33 feet apart at the top and they were later moved to 17.66 feet. The remarkable observation was made, that in the first case they were 0.08 ft., and in the second case 0.07 ft., further apart at the base than at the top. It was pointed out that a deflection of such an amount could not be explained as due to the gravitational attraction of the walls of the shaft for the nearer plumb-bob. Professor Hallock suggested that the effect was probably due to the magnetization of the wire and the consequent repulsion of the north poles at the bottom. In order to test the possible applicability of this theory a number of experiments were made in the research shaft at Columbia University which gave much corroborative evidence. Two plumb-lines about 85 ft. long were suspended in the shaft. One was of copper wire and the other of iron wire, about 0.03 in. in diameter. Lead weights were attached and it was found that the lines were about $\frac{1}{75}$ in. closer together, at the bottom, when the iron line was south of the copper than when it was north. Two lines of iron wire were also used and the distance apart at top and bottom measured. The deflections obtained were of the same order of magnitude as those produced by the earth's field. The deflections, thus obtained, give evidence of the action of magnetic forces of sufficient magnitude to explain the deviations observed in the plumb-lines in the Tamarack shaft.

Professor Hallock also described a form of recording thermometer which he had lately devised. It consists of a large copper bulb

which was connected by means of capillary copper tubing to a series of cells similar to those used in the construction of aneroid barometers. The bulb, tube and cells, were filled with oil and the recording mechanism attached to the aneroid cells.

F. L. TUFTS,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the 545th meeting, held on January 18, 1902, Mr. L. P. Shidy, Chief of the Tidal Division, Coast and Geodetic Survey, gave a brief 'Explanation of the Currents in Unalga Pass, Aleutian Islands, Alaska.' Dr. Dall spoke of the difficulties of navigation in this pass when there is a strong current, and of the unaccountable dying away of the wind near the center of the pass.

He said that these currents seem to conform to Torricelli's theorem for the flow of liquids due to a difference of head, which may be expressed thus:

$$V=\sqrt{2gd} \text{ feet per second,}$$

where $g=32.1722$ feet = the velocity of a falling body at end of first second, and d = the difference in feet between the elevation of the water surfaces at each end of the strait.

If we extract the square root of $2g$, we have

$$V=8.0215\sqrt{d} \text{ feet per second,}$$

or converting this into nautical miles per hour, it becomes

$$V=4.75\sqrt{d} \text{ knots,}$$

in which d is expressed in feet, as before.

The tides at each end of Unalga Pass were tabulated in the accompanying table.

The computed velocities of the current in the given table were obtained by the application of Torricelli's theorem. It may be remarked that there is, in general, a satisfactory agreement between the observed and computed velocities. The times of changing direction of flow are correctly given by computation, and the interesting phenomenon which occurred at 16 hours on June 14, 1901, where the southerly current had decreased to 1 knot, and then increased again without reversing its direction, is reproduced by computation within small limits of error.

TIME.	TIDE.		CURRENTS. + Indicates a Northerly Current. — Indicates a Southerly Current.	
12 = Noon.	South End of Pass.	North End of Pass.	Computed.	Observed.
Hour.	Feet.	Feet.	Knots.	Knots.
June 14, 1901				
8	3.14	2.91	+ 2.3	+ 2.6
9	3.75	3.20	+ 3.5	+ 3.7
10	4.38	3.87	+ 3.4	+ 3.1
11	5.00	4.69	+ 2.6	+ 1.9
12	5.66	5.63	+ 0.8	+ 0.6
13	6.31	6.38	— 1.2	— 1.1
14	6.86	7.12	— 2.4	— 2.4
15	7.21	7.34	— 1.7	— 1.7
16	7.20	7.28	— 1.3	— 1.0
17	6.84	7.03	— 2.1	— 1.8
18	6.68	6.89	— 2.2	— 2.0
June 15, 1901				
8	2.86	3.17	— 2.6	— 2.4
9	3.02	3.06	— 1.0	— 0.5
10	3.78	3.22	+ 3.6	+ 3.8
11	5.22	3.75	+ 5.7	+ 5.8

Professor J. H. Gore gave an account of the proposed 'Draining of the Zuider Sea,' illustrated by many lantern slides. The old plans have been found commercially impracticable, and the plan definitely recommended by a large Commission appointed in 1892 is the following: Only those portions are to be reclaimed that have a clay bottom; this leaves free

the mouths of the rivers and the present lines of water communication. First, a great sea dyke should be built at the north end with many locks, and with sluiceways to allow drainage at low tide; this will require some ten years and cost $16,000,000. Then a tract of 52,000 acres in the N. W. part should be dyked and drained, requiring five years and $5,000,000. Continuing the work, in all about a million and a quarter acres would be reclaimed in thirty-three years' time at a cost of $69,000,000. Experience shows that such lands can be rendered arable in about three years; and it is estimated that they could be rented by the state at $7 per acre per year. The report is a model of thoroughness for its consideration of every interest involved. The project now awaits the consideration of the legislative body.

Charles K. Wead,
Secretary.

THE ELISHA MITCHELL SCIENTIFIC SOCIETY.

The Society held its one hundred and thirty-eighth meeting on Jan. 21 at the University of North Carolina. The following papers were read:

'Recently Discovered Minerals in North Carolina': J. H. Pratt and Collier Cobb.

'Arizona, Its Mineral Wealth': J. H. Pratt.

Chas. Baskerville,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE DAILY BAROMETRIC WAVE.

In the *Monthly Weather Review* for Nov., 1901, Dr. O. L. Fassig has an interesting article on 'The Westward Movement of the Daily Barometric Wave.' The article is illustrated by charts showing the lines of equal pressure departure in the western hemisphere for each hour of the day for the month of July. Dr. Fassig's study was suggested by my own paper on the eclipse cyclone and the diurnal cyclones, but he was the first to complete charts of this kind and his charts add much to a knowledge of the behavior of the daily barometric wave and will no doubt aid materially in clearing up the cause of this wave.

The charts show very clearly that the diurnal areas of high and low pressure have distinct centers like the cyclones and anticyclones of the weather map, but unlike the latter move rapidly toward the west instead of toward the east. Moreover, the charts show very strikingly the effect of ocean and continent on the depth and position of the diurnal areas of high and low pressure, and one can scarcely doubt that surface heat and cold play a very important part in their formation.

Particularly instructive in this connection is the behavior of the early morning minimum of pressure. At 2 a. m., 75th meridian time, it is chiefly over the two Atlantic oceans, and is central over the North Atlantic, the cold ocean at this time of year when contrasted with the surrounding continents. Between 3 a. m. and 6 a.m. this barometric minimum passes over the land areas of North and South America and then the low pressure is found central over the cold southern continent where winter prevails, and the pressure scarcely falls below normal in the warmer northern continent. These facts appear to point very clearly to the dependence of this depression on a relatively low surface temperature, and are in line with the suggestions in my papers on the eclipse cyclone and the diurnal cyclones, namely that the morning minimum of pressure is the result of a cold air cyclone.

The afternoon barometric minimum moves from South America to North America during the afternoon following the place of highest temperature, thus indicating its dependence on surface heating.

Mr. Fassig does not state from what source his data are obtained. In drawing my own charts I have found a great scarcity of data from over the Pacific Ocean. The data for South America will be greatly added to when Professor Bailey's observations are published in the Harvard *Annals*. In constructing my own charts I scaled off the values at his stations from the curves published by him in the *American Meteorological Journal*, Vol. XII., p. 331.

H. H. Clayton.

NOTES ON INORGANIC CHEMISTRY.

NEW BORIDS.

AMONG the compounds which the high temperature of the electric furnace has rendered easy of preparation are the borids of the metals, few of which were known until within the last decade or so. Moissan has described the borids of the alkaline earths, of iron, nickel, and cobalt, and of carbon and silicon. In the last number of the *Journal of the Chemical Society* Tucker and Moody recount the preparation of the borids of chromium, molybdenum and tungsten, and of zirconium. All were made by heating the mixed elements in the electric furnace, and are crystalline bodies of great hardness; they are but slightly attacked by hot concentrated acids, except that the molybdenum and tungsten borids are vigorously acted on by hot aqua regia. The formulas obtained by analysis are, CrB, Mo_2B_5, WB_2, and Zr_2B_4. The authors suggest that as a consequence of their high fusing point, hardness, and good crystallization, it is quite possible that some of these and other borids may prove to have industrial uses.

ETHYLENE FROM INORGANIC SOURCES.

IN a recent *Journal of the Society of Chemical Industry* the same authors describe the production of ethylene from inorganic sources. Since calcium carbid when treated with water evolves acetylene, and aluminum carbid evolves methane, it was hoped that a mixture of these carbids would give ethylene, but this was found not to be the case; only acetylene and methane were obtained. When, however, a mixture of barium silicid, which evolves hydrogen, with calcium carbid is decomposed by water, ethylene is present in the evolved gases to the extent of two per cent. If barium carbid is substituted for the calcium carbid, the gases contain up to fifteen per cent. of ethylene.

ORGANIC ARAGONITE AND CALCITE.

A NEW reaction to distinguish between aragonite and calcite is given by W. Meigen in the *Centralblatt für Mineralogie*. The finely powdered substance is boiled for a few moments with a dilute solution of cobalt nitrate. In the presence of aragonite a lilac red precipitate of basic cobalt carbonate is formed, while calcite remains uncolored even after prolonged boiling, or is occasionally colored yellow. Magnesium carbonate is also unchanged in color and calcium phosphate gives a blue precipitate. Using this diagnostic reaction upon shells, corals, and other animal remains, both recent and fossil, the author gives long lists of those consisting of aragonite and calcite respectively. No rule of distribution is apparent from his lists; most orders, recent and fossil, are represented in both classes. The larger number of corals are aragonite, but corallium and tubipora are calcite; the outer shell of trigona is calcite while the inner shell is aragonite; the argonauts are calcite but nautilus and sepia are aragonite; hens' eggs are calcite.

UTILIZATION OF FLUORIN FROM FERTILIZER PLANTS.

WHEN natural phosphates are decomposed by sulfuric acid in the manufacture of superphosphate fertilizers, there is a considerable quantity of hydrofluoric acid set free as such, or as fluorid of silicon. This is especially the case when apatite is used; indeed this fact detracts very materially from the value of the immense apatite deposits of Canada. In Germany manufacturers are compelled by law to prevent the escape of these deleterious gases into the atmosphere and efforts are being made to utilize the waste product. By leading the gases through water, fluosilicic acid is formed and from this solution sodium fluosilicate or magnesium and aluminum fluosilicates may be readily prepared. The last two have some use in hardening calcareous stone. More recently it has been discovered that fluosilicic acid has strong antiseptic properties and that as a preservative of manure it surpasses plaster, kainite or superphosphate of lime. The denitrifying action of bateria is checked, preventing the loss of nitrogen. The greatest difficulty in the way of its adoption for this purpose is its preparation in suitable form. The aqueous acid in bottles would hardly be acceptable to the farmer and no satisfactory absorbent of the acid has been found. A patent for a new manure preservative has recently been taken out, in which the fluosilicic acid

is incorporated with clay, with the bases of which it for the most part combines. With this powder goes another consisting of a porous substance saturated with sulfuric acid. A small quantity of each powder is scattered over the manure pile and by the action of the sulfuric acid on the fluosilicates fluosilicic acid is generated which acts as an antiseptic. In describing this process in the *Chemiker Zeitung* C. Elschner suggests that it would be more economical to absorb the gases directly by lime and then dry the calcium fluosilicate formed, and that a powdered bisulfate could be more advantageously used than sulfuric acid. Should some practicable method be devised for utilizing these noxious gases it would give great value to many apatite deposits which contain too much fluorspar to be utilized at present.

A GYPSUM WEATHER-SCALE.

Around the 'Stone Gallery' at the base of St. Paul's Cathedral is a balustrade of Portland stone, surmounted by a heavy coping of the same material. All of the stone is greatly weathered and coated with a gray or black deposit, much resembling boiler scale. Under the coping this attains a thickness of three-quarters of an inch. An examination of this deposit is given by E. G. Clayton in the *Proceedings* of the Chemical Society. It contains no fungoid matter, and contrary to expectation no carbonates were found in it. It is essentially calcium sulfate, with a small amount of silica. Since there is no neighboring source of sulfates the conclusion is reached that it has been formed by two centuries' solvent and weathering action of rain, charged with sulfurous and sulfuric acids derived from the gases and smoke of innumerable surrounding chimneys. The rain water, running and dripping from the under side of the coping stone, has here left an especially thick deposit, which presents a curiously close resemblance to a deposit of calcareous tufa.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

PHYSIOGRAPHY OF WISCONSIN.

Collie has contributed two articles on the physiography of his State. The first ('Physiography of Wisconsin,' *Bull. Amer. Bureau Geogr.*, II., 1900, 270–287) is a general and elementary account, giving fuller statement of features due to glacial action than to those determined by the underlying rock. The second ('Wisconsin shore of Lake Superior,' *Bull. Geol. Soc. Amer.*, XII., 1901, 197–216) is the result of detailed local study, with special reference to shore features in the neighborhood of the Apostle Islands. These islands consist of horizontal sandstones, usually cliffed and caved along the waterline, but also modified by bars and spits, of which the largest encloses Chequamegon bay.

In both these papers the bluff by which descent is made from the northwest border of the uplands of disturbed Keweenawan rocks to the lower land of horizontal sandstones bordering Lake Superior is described as a fault scarp, 'formed by the movement of rocks one upon the other, * * * particularly noticeable because it is not formed, as most of the Wisconsin cliffs are, by erosion.' This interpretation of the recency of the fault is novel. The considerable erosion indicated by the truncation of the upturned edges of the sandstones near the fault line throws some doubt upon the accuracy of Collie's view; should it be proved correct the scarp would be an interesting addition to our physiographic types, for faults that are young enough to preserve something of their initial topographic expression are rare in the eastern half of our country.

GLACIAL EROSION IN SKYE.

The laccolithic mass of the Island of Skye, west of Scotland, was deeply dissected in preglacial time. During the glacial period, its mountains bore local glaciers, whose eastern members stemmed the great ice sheet that came westward from the Scotch highlands, dividing it into two parts which flowed northwest and southwest out to sea. The effects of the Skye glaciers as agents of erosion have lately been studied by Harker ('Ice Erosion in the Cuillin Hills, Skye,' *Trans. Roy. Soc. Edinburgh,* XL., 1901, 221–252, map). He finds that the floors and walls of the ice-scoured valleys exhibit much less relation to rock structure than is usual in districts of

subaerial erosion only, and regards this as a natural consequence of the massiveness and relative rigidity of the ice streams. The valleys are comparatively straight, with broad floors and rather smooth and steep sides, heading in amphitheaters or corries that seem unduly large for their drainage areas. The valley floors frequently descend by abrupt slopes to lower and lower levels. Rock basins, excavated in the valley floors, and holding lakes, are justly regarded as subordinate and incidental to the general scouring of the shallower and narrower preglacial valleys to their present trough-like form. Short side glens open characteristically on the walls of the larger valleys to which they are tributary. The divides between the uppermost corries of the main valleys are sharply serrate, in consequence of the retrogressive erosion of the glaciers that headed in the corries, as has been pointed out by Richter for the Alps, and by Matthes for the Big Horn range of the Rocky mountains.

The comparison instituted by Harker between rivers and glaciers is not altogether satisfactory inasmuch as it fails to point out certain similarities between the two. It is stated that, 'the bed of a river which has attained a mature state maintains a steady gradient so long as the volume of water is unchanged'; but it is the surface, not the bed, of the river that should be thus described. The bed of a mature river, such as the Mississippi, has numerous hollows, whose dimensions are to those of the river in about the same proportion as the dimensions of rock basins are to those of the glaciers that scoured them out. When a mature river crosses a reef of resistant rocks, it habitually sweeps out a shallow basin-like depression in the weaker rocks next up stream; while another basin may be eroded by the plunge of the waters down stream from the reef. Rivers whose volume is greatly reduced in the dry season exhibit the hollows in their bed as a series of pools strung together by the diminished stream. It therefore seems wrong to say that 'ice erosion does not, like water erosion, work constantly towards the establishment of an even gradient along a valley.' Both tend to establish even gradients in their surface; both produce inequalities in their beds; the inequalities of a river bed receive little attention; they are comparatively small and are usually out of sight; the inequalities in the beds of existing glaciers are even less open to observation, although it can hardly be doubted that they exist. The inequalities in the beds of extinct glaciers are often so large and so plainly visible that their analogy with the hollows in river beds is too commonly overlooked.

THE SEVERN BORE.

A SERIES of views of the Severn bore taken with a bioscope camera by Vaughan Cornish was thrown on the screen at a meeting of the Royal Geographical Society of London in November last, the first cinematographic illustration of this tidal phenomenon. Four of the views are reproduced in the *Geographical Journal* for January, 1902, and show the approach and passage of the bore with some distinctness. Cornish proposes to make similar studies of other tidal rivers. His well-known studies of rippled sands, under waves, tides and winds have been published in recent years.

W. M. DAVIS.

RETIREMENT OF MONSIEUR HATON.

THE report of the proceedings at a meeting of the faculty, alumni and friends of M. Haton de la Goupilliére on the occasion of his retirement from the directorship of l'Ecole nationale supérieure des Mines, accepting Vice-Presidency of the Conseil général des Mines is just distributed. This ceremony took place June 8, 1901, in the great auditorium of the Société d'Encouragement. The list of contributors numbered 580 and the farewell offerings were numerous and various, including a bust of M. Haton and bronzes by Dubois and others. The bust is reported to have proved a very accurate likeness of its distinguished original. The addresses were made by M. Carnot, Director of the Ecole des Mines, and M. Lemonnier, president of the Association.

M. Haton was 'Élève ingénieur' in 1852, when about 20 years of age, was made professor in the preparatory course immediately on graduation as Ingénieur, taught general

chemistry in 1855 and mathematics pure and applied; in 1872 he became professor in the course then including machines and exploitation of mines, and became director of the School of Mines in 1887, where he remained until the end of the XIXth century, nearly a half-century of continuous service, substantially all at l'Ecole des Mines. His principal works had meantime been published, on 'Mines and Mining' and on 'Thermodynamics and Motor-Machines.' He had been called to serve on several international juries, and on various commissions, and had earned many honors, including that of Member of the Institute in 1884 and of 'grand-officier' of the Legion of Honor in 1900.

In replying to the cordial and eloquent addresses of MM. Carnot and Lemonnier, M. Haton stated that alumni of the school had supplied 39 members of the Institute and 8 'Correspondents':

"Hommes d'action, hardis explorateurs, chez de grandes industries, ingénieurs chargés de la conduite des travaux ou des affaires, ils soutiennent dans le monde entier le bon renom de l'École."

The *Compte Rendu,* as its frontispiece, has an excellent portrait of M. Haton de la Goupillière. It indicates that its original retains his youth and vigor wonderfully and we may hope for him many more years of active, fruitful and honorable life. His friends in this country will cordially unite with those about him in wishing for him 'many happy new years.'

R. H. Thurston.

SCIENTIFIC NOTES AND NEWS.

Professor E. C. Pickering has completed twenty-five years of service as director of the Harvard College Observatory, and in recognition of the fact the staff of the Observatory has presented him with a silver cup.

The condition of Professor Rudolf Virchow, who recently suffered an injury from a fall, causes apprehension to his physicians.

Dr. W. W. Keen, who is at present in India, recently fell from his horse, fracturing one of his clavicles. The accident was not serious.

The daily papers state that President Roosevelt has overruled the decision of Secretary Long to send Capt. Charles H. Davis, superintendent of the Naval Observatory, to sea.

Dr. Henry B. Kümmel was appointed state geologist of New Jersey by the board of managers of the Geological Survey at their meeting on January 10. Mr. Kümmel has been connected with the Survey since 1892, and since 1899 has been assistant state geologist, being in charge of the work since Dr. Smock's resignation last July. He is a graduate of Beloit College, A.B. 1889, and did post-graduate work in geology at Harvard University, and the University of Chicago, from which he received the degrees of A.M. and Ph.D. respectively. He was elected a fellow of the Geological Society of America in 1895.

Samuel McCune Lindsay, assistant professor of sociology in the University of Pennsylvania, has been nominated for Commissioner of Education in Porto Rico.

The Paris Academy of Medicine has awarded its Hugo prize of $200 for the best work on the history of medicine to Dr. Melanie Lapinska for her book on the history of women physicians.

Dr. Charles H. Burnett, a well-known writer on diseases of the ear, died at Bryn Mawr, Pa., on January 30, aged sixty-one years.

Lieutenant von Siegsfeld, after a balloon ascension from Potsdam to study artificial respiration, was killed in the descent.

The American Philosophical Society, Philadelphia, has arranged for a general meeting on April 3 and 4, and a large number of scientific men from all parts of the country have signified their intention of being present. Members wishing to present papers are asked to communicate the titles to the secretaries without delay, so that they may be inserted in the preliminary program which will be issued as soon after February 15 as practicable. Members expecting to attend the meeting are requested to notify the secretaries at as early a date as possible so as to facilitate the arrangements for their entertainment.

The 'Leopoldinisch-Carolinische Akademie deutscher Naturforscher,' now in Halle, cele-

brated the two hundred and fiftieth anniversary of its foundation on January 1. The academy, under the name, 'Academia Naturæ Curiosorum,' held its first meeting in Schweinfurt on January 1, 1652, and is thus the oldest academy of sciences north of Italy, the Royal Society having been established in 1662, and the French Academy in 1666. The academy began the publication of proceedings in 1670 and enjoyed extraordinary privileges, the president and secretary being elevated to the nobility, the former with the rank of count. At the present time the Academy has about nine hundred members and is planning for the erection of a new building.

THE Association of American Universities will hold its annual meeting at Chicago on February 25, 26 and 27.

PRESIDENT HADLEY, of Yale University, will give six Lowell lectures at Boston on 'The History of Academic Freedom.'

PROFESSOR B. E. FERNOW, of the College of Forestry, Cornell University, will lecture in Ottawa, Canada, on March 6, before the Canadian Forestry Association.

UNDER the auspices of Columbia University, Professor William D. Burr is giving at the Cooper Union the following lectures on mechanical engineering:

February 4, 'Ancient Civil Engineering Works.'

February 11, 'Bridges.' The latter portion of the lecture will include the treatment of masonry arches and suspension bridges, with examples of applications to the longest spans yet contemplated.

February 18, 'Water Works for Cities and Towns.'

February 25, 'Some Features of Railroad Engineering.'

March 4, 'Nicaragua Route for the Isthmian Ship Canal.'

March 11, 'The Panama Route for the Isthmian Ship Canal.'

The lectures will be issued in book form by the Columbia University Press.

THREE lectures, in German, by Max Uhle, Ph.D., Hearst lecturer in anthropology, and director of the excavations and explorations of the University of California in Peru, are being given as follows:

February 3 and 5, 'The Sources of Ancient Peruvian Civilization.'

February 10, 'Some Incasic Ruins of Central-Peru.'

ARTHUR CURTISS JAMES, ESQ., has purchased the collection of Ainu objects made by Professor Bashford Dean last year and has presented it to the American Museum of Natural History. The Museum has also received from Mr. W. Jochelson, of the Jesup North Pacific Expedition, his Koryak collection from Siberia, consisting of about 1,200 pieces, among which there are many objects of prehistoric age.

PROFESSOR J. S. KINGSLEY, Tufts College, announces that the summer school of biology known as the Harpswell Laboratory, established at South Harpswell, Maine, in 1898, will be open from June 16 to September 13, 1902; the regular courses of instruction beginning July 2, and continuing for six weeks. The laboratory is a small wooden building directly on the shore and affords accommodations for fifteen or twenty students. South Harpswell is in Casco Bay, sixteen miles from Portland, from which place it is reached by steamer. Casco Bay has a rich fauna and flora and is not excelled as a collecting ground by any point between Eastport and North Carolina. Already 529 species of invertebrates have been reported from its waters and many novelties turn up each season. South Harpswell itself is well situated, being at the extremity of a narrow peninsula, ten miles in length, thus ensuring freedom from hot weather. In 1901 the thermometer did not reach 80° in the laboratory.

THE New York State Medical Society at its session in Albany on January 29 received recommendations of the legislative committee as follows:

That local Boards of Health be requested to follow the work of the Milk Committee of the New York City Medical Society in the efforts made to provide pure milk.

That the recommendation making toward the establishment of a National Health Board, with a representative in the President's cabinet, be indorsed.

That the questions involved in Dr. Koch's pa-

per at the London Tuberculosis Congress upon 'The Communicability of Bovine Tuberculosis' invite further experiments in this field before any conclusions can be drawn that would modify existing methods for dealing with the disease.

The report of the library committee for 1901 of the College of Physicians of Philadelphia, as abstracted in the *Philadelphia Medical Journal,* shows 64,916 volumes in the library, including 1,070 duplicates. 4,079 volumes have accumulated since July, when all duplicates on hand were disposed of. In addition to the volumes, there are in the library 58,395 unbound pamphlets, reports and transactions. The library regularly receives 356 medical periodicals, 86 of which are American, and 270 foreign. 2,212 inaugural dissertations have been received during the year.

At a meeting of the Royal Institute of British Architects on January 21, a paper on 'The Recent Architectural Discoveries at Stonehenge' was read by Mr. Detmar Blow, who, with Dr. Gowland, superintended the excavations which were made in October last for Sir E. Antrobus. Mr. Blow, according to the report in the London *Times,* pointed out that the great monolith called the leaning-stone was the largest in England, Cleopatra's needle excepted. It was one of the pillars of the highest trilithon, and stood behind the altar-stone near which it leaned at an angle of 65 degrees. Half-way up it had a fracture one third across it; and the weight of stone above that fracture was a dangerous strain on it. It had now been brought to a vertical position. One Roman coin and one George III. penny were found quite near the surface. Numerous chippings of the sarsen and blue stone of which Stonehenge was built were discovered. The flints found were used for the softer sarsen and blue stones, and the hand-hammers and mauls for rough dressing. From this the deduction had been made that the building belonged to the Palæolithic period. All authorities agreed that it was the work of a highly civilized people. The construction was one of a stone development and the surface of the stone was finished much like that of granite. The design of the pillars was in his opinion evolved from the shapes of the flint instruments used by the workman, to which his hand had grown accustomed. Each pillar had a bold entasis in its elevation, and in its plan foreshadowed the column. With the aid of the illustrations he described the method of raising the leaning stone and the sifting process, the articles found being afterwards shown to the audience. Stonehenge having been generally supposed to be of the bronze age, it was with great joy that he lighted upon the stone implements. It was, he believed, the only occasion on which the implements were found actually next to the stone building where they were used. Sir Norman Lockyer, in opening a discussion on the paper, said he believed archeologists had come to the conclusion that, from the evidence which had been obtained, they were justified in assuming that the sarsen stones were erected in the Palæolithic times—that was to say, before the age of bronze, or at all events before bronze had been used for any ordinary kind of work in that part of England. Before the excavations were commenced Mr. Penrose and himself had been occupying themselves with Stonehenge from a slightly different point of view. They were very anxious to determine its age, and it was found much easier to get certain astronomical data from Stonehenge owing to its position than from other ancient monuments. He gave a number of astronomical data in support of his assumption that Stonehenge was a solar temple and one used for observation in the height of summer. From their observations they came to the conclusion that the avenue which was associated with the sarsen stones was laid down about the year 1680 B. C. Such temples as Stonehenge were erected in the very first blush of civilization in order that the people should be able to fix the time for performing agricultural operations. He thought that Mr. Penrose and himself had been able to show beyond all doubt that we had in Stonehenge a temple for observing the length of the year by observing the rising of the sun on the longest day of the year, although in other parts of England there were temples for observing the sun not on June 21 but early in May and early in August.

The *American Museum Journal* reports

that through the generosity of a friend of the Museum, who desires to have his name withheld from the public, six groups have recently been added to the very attractive and instructive series representing birds amid their natural surroundings which are to be seen in the halls of the Ornithological Department. The new groups represent the American dipper, or water-ousel, the osprey, the yellow-headed blackbird, the coot, Wilson's phalarope and the wild pigeon. The material for the first-named was gathered by Mr. Frank M. Chapman last summer on the banks of a rushing icy stream issuing from a glacier in the Selkirk mountains of British Columbia. The rocky bank of the stream, the nest in the cleft of the rock and the birds in and about the nest have been reproduced with lifelike fidelity in the Museum exhibition case. Mr. Chapman collected the specimens and accessories for the osprey group on Gardiner's Island, off the eastern end of Long Island, and those for the blackbird, coot and phalarope groups at Shoal Lake, Manitoba. The twelve specimens included in the wild-pigeon group were secured with much difficulty from collectors and dealers throughout the country, the surprising fact being incidentally developed that a species which, within the last fifty years, was one of the most abundant native birds of this country, is now so rare, not only in nature, but also in collections, that specimens of it are practically unobtainable. Each of these new groups is designed to illustrate not only the haunts and habits of a species of birds, but also some fact of general biological interest. This feature will be fully set forth in the labels accompanying the cases.

AT the annual meeting of the Mathematical Association, London, Professor A. Lodge read a paper introducing for discussion the subject of improvements in the teaching of elementary mathematics. According to the report in the London *Times* he explained that the special object in bringing the whole question forward now was to enable the Association to cooperate with the British Association committee formed for the purpose at the Glasgow meeting last year. Many teachers had been for a long time aware that the teaching of geometry in this country was suffering from its being based on a fixed ancient model which, however excellent, was not in many respects satisfactory as a text-book for beginners. The efforts hitherto made had been powerless to make any appreciable effect on the action of the great examining bodies in the country, and without their cooperation much progress was not possible. Now, however, with the powerful leverage of the British Association to assist them, the Association might confidently look for real and lasting progress. The best method of teaching geometry would, no doubt, be the question which would require most attention, as that was a matter in which all, teachers and examiners, must move together if at all. Men came up to engineering colleges who were slow and inaccurate in computation, who did not know the contracted methods of multiplication and division, who were as likely as not to put the decimal point in the wrong place. They wanted boys taught to be ready and rapid computers, to be able to make rough checks on their own work so as to avoid gross errors, to cultivate common sense in connection with problems, and to be in the habit of verifying answers. It had to be remembered that the pupil's mental equipment was chiefly arithmetic and algebra, and his geometry should be built on these notions as much as possible, instead of being carefully divorced from them, as was done in so many text-books. It would be advisable at the outset to adopt some French text-book as our model. The Americans had done so already, and the chief points in their books were: (1) The more orderly arrangement of propositions; (2) the entire separation of theorems from problems of construction, hypothetical constructions being used in proving a theorem; (3) the closer association of a proposition and its converse when both were true; (4) the adoption of arithmetical notions and algebraic processes; (5) the early introduction of simple *loci;* (6) insistence on accurate figures drawn by accurate and practical processes; (7) practice in exercises from the very beginning. It had been suggested that he should add, 'Attention paid to the various phases of a theorem as the figure

changes, and (as the student progresses) to the easier forms of generalization.' The greater part of these improvements could be adopted at once, provided that the sanction of the great examining bodies could be obtained. In conclusion he urged on all who were convinced that reform in geometrical teaching on some such lines as he had indicated was urgent and imperative that they should not rest content until some at least of the reforms were sanctioned by the great public examining bodies. The meeting ought not to conclude without appointing a strong committee to keep in touch with the British Association committee.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. John D. Rockefeller has offered to give $1,000,000 toward the construction, equipment and endowment of the new buildings of the Harvard Medical School, on condition that $500,000 be secured from other sources.

Allegheny College has recently added two hundred thousand dollars to its endowment fund through the efforts of the president, Dr. Wm. H. Crawford.

Dr. Nicholas Murray Butler will be installed as president of Columbia University on April 19. The ceremonies will be similar to those on the occasions of the installations of Presidents A. P. Barnard and Seth Low. The charter and keys of the University will be presented by Mr. William C. Schermerhorn, chairman of the board of trustees, to the president-elect, who will respond briefly, and who in turn will be succeeded by speakers representing faculty and alumni. Brief speeches of greeting will be made by Presidents Eliot and Hadley and by representatives of other universities, and the program will conclude with the president's inaugural address.

Rev. Daniel S. Bradley, of Grand Rapids, Mich., has been elected president of Iowa College, Grinnell, Iowa.

The Supreme Court has dismissed the suit of the New York University against the Loomis Laboratory to gain possession of its property.

Owen's College, Manchester, will celebrate in March the fiftieth anniversary of its foundation.

Professor Hugo Münsterberg, as chairman of the philosophical department of Harvard University, is making special efforts to secure funds for the erection of a building for the department, to be known as Emerson Hall. Plans have been drawn by Mr. A. W. Longfellow, according to which the hall is to be a three-story structure, of red brick. On the first floor there will be small recitation rooms and one large lecture hall, seating 400 students. The rest of the floor will be taken up by a philosophical library, comprising an extensive collection of philosophical works. The second story will contain small recitation rooms and seminary rooms for advanced work. The entire third floor will be used for a psychological laboratory. There will be one large room, where work of a general character may be done. The rest of the laboratory will be divided into fifteen sections, each of which will be specially equipped for certain specific branches of the subject.

It appears that the elective courses of the junior year at Yale University have been selected by students, as follows: History 390, English 374, philosophy and psychology 336, social science 323, German 117, French 97, Latin 36, Greek 21, geology 112, chemistry 85. Philosophy and psychology were last year made elective for the first time and are doubtless more popular than when they were required. The classical languages appear to fare badly, for it is probable that only those who carry them into the junior year get an adequate return for required routine work of previous years.

The reorganization of the faculty of the Imperial University at Pekin, with the retirement of President Martin, is contemplated. He criticised the government severely after the siege of the legations, but his age is the principal reason for his removal.

R. J. Paranjpe, the Hindoo who was senior wrangler of Cambridge University three years ago, has returned to his native country, and has been given a professorship at Fergusson College, Poona.